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from your president

During our recent meeting at San Francisco, your Executive Council was apprised of a proposal offered before the Workshop on Dental Specialties conducted by the Council on Dental Education of the A.D.A., that the number of recognized specialties be limited to six and that Pedodontics be considered a sub-specialty of Orthodontics.

As your President, I conveyed to Mr. Shailer Peterson, Secretary of the Council on Dental Education, the vigorous disapproval by your Executive Council, of such a proposal.

While it may be true that both specialties, Pedodontics and Orthodontics, are concerned primarily with children, the emphasis of the two specialties is quite different. Certainly Pedodontics is concerned with growth and development, but at the same time this field is only one of the aspects of the body of knowledge in Pedodontics. Others deal with dental caries from a preventive as well as a treatment standpoint. There is an increasing emphasis on the better use of dental materials in pedodontics and there also is an increasing use of knowledge concerning the supporting structures of the teeth. Pedodontists are also concerning themselves increasingly with the general considerations of the management of handicapped children, and here certainly is a big departure in emphasis from the orthodontists' viewpoint.

For these and other reasons, the executive Council of the American Society of Dentistry for Children wishes the Council on Dental Education to take our viewpoint into consideration in any further deliberations about compartmenting the specialties in dentistry. Personally, I feel that there may be some arguments in favor of a reverse organization; i.e., that Orthodontics be considered a sub-specialty of Pedodontics.

HENRY M. WILBUR

The Ultrasonic Dental Unit in Pedodontics

Doran D. Zinner,* D.D.S. and Wendell L. Whetstone, D.M.D.**

In recent years, the dental profession has witnessed the introduction of a large number of new instruments in the operative field. In view of this constantly growing armamentarium, the dentist shoulders a heavy responsibility in selecting those new tools which will most improve his services to the patient—as regards both operating efficiency and patient comfort.

For the pedodontist, who is at once both teacher and operator, in that he is responsible for introducing the child patient to dentistry and to oral hygiene as well as responsible for the completion of the necessary restorative work—the problem of instrument evaluation and selection is perhaps weightiest of all.

The attitude of the child and future adult towards dentistry and the intelligent care of his teeth depends largely upon his orientation to his first dentist and his initial experiences in the dental office.

With this responsibility in mind, therefore, it was decided to investigate and evaluate the new ultrasonic dental unit† and its possible applications to pedodontics, when it first became available for limited clinical evaluation in the fall of 1954. The ultrasonic dental unit introduced into dentistry a completely new means of utilizing mechanical vibration in the removal of tooth structure with a minimum of heat, noise and vibration. It was felt that the elimination of gross vibration and the reduction of the heat and noise which the instrument makes possible might well prove a boon in dentistry for children.

Now, after a year of routine office use of the ultrasonic dental unit and after continued post-operative checkups on a large number of cases, including six month post-operative radiographic and general examination, as well as a number of pulp-test follow-ups, we believe the ultrasonic dental unit to be as safe and efficient an instrument as the conventional rotary instrument.

In addition, the ultrasonic dental unit has one advantage which we believe will prove to be of major significance in pedodontics. This is the fact that its routine use enormously reduces the fear and apprehension of the child patient, enables the operator almost to eliminate the use of anesthesia and makes it possible for the patient to accept, with comfort and without anesthesia, more actual dental work per chair hour than has been our experience with rotary instruments.

This makes it possible for the operator to provide more complete and in many instances, better dental care and lays the foundation for a more pleasant and relaxed relationship between operator and child patient.

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** Chief Dental Service, Variety Children's Hospital, Miami, and staff member, Dade County Dental Research Clinic.

† The Cavitron Ultrasonic Dental Unit.

Project Outline

This report covers 123 patients of both sexes and ranging from 3½ to 15 years of age. It extends in time from February 2, 1955 to January 10, 1956.

A total of 437 teeth, prepared either with rotary instruments or the ultrasonic dental unit, constitute the material upon which the study is based. Of this total, 51 teeth were prepared with rotary instruments, 380 teeth prepared with the ultrasonic dental unit and six teeth were set aside as controls for a particular phase of the project.

In all, there were 283 permanent teeth and 148 primary teeth prepared, covering all categories of cavity preparation and randomly occurring as they did in a routine pedodontic practice, except for a small number of orthodontically condemned teeth selected for extensive post-operative follow-up and eventual sectioning for histologic study after extraction.

The study is divided into three distinct phases, each phase providing for a different level of post-operative follow-up. The first two phases, including 399 teeth prepared upon 109 patients, cover data collected over a year's time in a pedodontic practice in a three chair office where only one room is equipped with an ultrasonic dental unit. Thus a limited number of patients, selected only by the fact that the "ultrasonic" room was available when they arrived for treatment, were treated with the ultrasonic dental unit.

Control Material

In order to provide for some clinical comparison, in patient reaction, efficiency of operation and safety as determined through clinical follow-up, a number of those patients were treated with both the ultrasonic dental unit and with rotary instruments during the course of the past year. The rotary instruments used operated at approximately 3,500 R.P.M. In addition, we arbitrarily selected September 1, 1954 as a cut-off date so as to include some additional rotary instrument history on those patients who had no rotary instrument work done in 1955.

Phase One

Six-month Post-operative Radiographic Follow-up

This phase of the study provides for radiographic and general clinical re-examination 6 months after operative treatment on 24 patients on whom 140 teeth were prepared beginning in the first week of February 1955. There were 59 permanent teeth—seven of which were prepared with rotary instruments—and 52 of which were prepared with the ultrasonic dental unit. Of 81 primary teeth, 37 were prepared with rotary instruments and 44 prepared with the ultrasonic handpiece.

Figure 1 contains the relevant case histories of six patients in this group, indicating the teeth prepared with each instrument. These cases are representative of the entire group of 24, whose complete data are not presented because of space limitations.

Bite-wing radiographs and general clinical check-ups six months after treatment revealed no unusual post-operative sequelae except in the case of one tooth where sensitivity and soreness led to the discovery of a draining fistula. Radiographs indicated some bone resorption on case 2 involving a DO preparation on the upper left primary molar which had been prepared with rotary instruments on May 16, 1955.

No clinical or radiographic evidence of abnormality of developing permanent teeth or their surrounding structures, nor of supporting structures of operated teeth was evident.

Patient, Check-up Date, Sex, and Age	Preparation Date	Rotary Preparation								Ultrasonic Preparation							
		Primary Teeth				Permanent Teeth				Primary Teeth				Permanent Teeth			
		1	2	3	5	1	2	3	5	1	2	3	5	1	2	3	5
Case No. 1 check-up 11/17/55, F, 10	9/24/54	/D MO /E MOD	/C D		/6	6/MO											
	9/29/54	E/DO E/MOD D/MO	C/D		6/	/6 MO											
	2/18/55														6/MO /6 MO		
	4/7/55										E/DO /E DO				/6 MO		
Case No. 2 check-up 1/16/56, F, 9	5/16/55	/E DO				/6 MO		/6 B									
	5/18/55												E/B		6/MO		6/B
	5/25/55										E/MOD	C/D			6/MO		6/B
	5/30/55									/C	/D MO				/6 MO		/6 B
	6/1/55											C/D				/1 D 1/D /2 M	
Case No. 3 check-up 12/5/55, M, 5	5/31/55	D/DO E/MO															
	6/7/55	/E MO /D DO															
	6/14/55										E/MO D/DO						
	6/22/55										/D DO /E MO						
Case No. 4 check-up 11/7/55 F, 11	2/23/55													/7		/1 D /2 M	
	3/2/55													7/ 6/ /7	5/DO		6/B
	3/9/55														6/DO /6 MO		
Case No. 5 check-up 12/22/55 M, 8	6/9/55	/E MOD						/2 M									
	6/13/55										/E DO E/MOD						
	6/21/55	E/MOD													/6 MO /6 MO 6/MO		
Case No. 6 check-up 1/5/56 M, 6	2/14/55	/E MO pulp cap															
	2/16/55										E/MO D/DO						
	2/24/55	/E MO	/C M														

FIG. 1. Six-month post-operative clinical and radiographic check-up, showing time elapsed on operated teeth, teeth operated, relative to text. (Representative phase one cases)

		Diamond UR 4	Ultrasonic LR 4	Ultrasonic LL 4	Control UL 4
Reading prior to preparation	Buccal	6½	7	9½	5½
	Lingual	5½	7	9	2½
10/27/55	Buccal	8	9½	9½	8½
	Lingual	5	8½	7	2½
11/4/55	Buccal	8	7	9	5
	Lingual	4½	8	6	2
11/9/55	Buccal	7	7	8	4
	Lingual	5	7	6	3
11/16/55	Buccal	11	4½	8	6½
	Lingual	5	7½	8	3
12/2/55	Buccal	10	8	10	10
	Lingual	3½	6½	6	2½

FIG. 2. Representative pulp test follow-up using burton vitalometer

PHASE TWO

Clinical Observation Before Six-Month Post-Operative Check-Up

Phase Two covers 85 patients having had 259 teeth prepared over the same period, February 2, 1955, to January 10, 1956. These teeth included 195 permanent teeth and 64 primary teeth. These patients either have not yet come due for their six-month post-operative radiographic check-up or have neglected to report although over-due. Nevertheless, post-operative examination immediately following tooth preparation and on succeeding visits did not reveal any unusual post-operative symptoms, nor was there any unusual hot-cold sensitivity reported.

General Comments on Phases One and Two

Included in the total of 399 teeth prepared for these two phases of the study were three inadvertent mechanical pulp exposures, all on primary teeth prepared with the ultrasonic dental unit. They were capped with calcium hydroxide and water and a rapidly setting zinc oxide-eugenol cement, and the cavities filled with amalgam at the same sitting. No indication of pain was given by the patients on exposure—no anesthesia was used—and the operator was surprised when checking the preparation to discover the exposures. The situation was explained to the accompanying parent in each instance and they were requested to return if any untoward symptoms developed. Thus far, the teeth involved are apparently in good condition.

On routine recall, there has been no clinical or radiographic evidence of abnormality of developing permanent teeth or their surrounding structures, nor of supporting structures of operated teeth.

Patient acceptance of the ultrasonic dental unit has been uniformly high. In using the instrument, a mixture of water and abrasive (finely divided aluminum oxide particles) is delivered to the operative area. Removal of the compound is accomplished by use of the ordinary saliva ejector, which appears to be satisfactory except in very young patients. A number of young patients under five years of age reject the ultrasonic dental unit because of the need for additional equipment in the mouth (saliva ejector), or because of a gagging reaction to the presence of the abrasive in the mouth. A similar objection to the addition of equipment would probably be registered where high-speed instrumentation requires the constant use of a saliva ejector.

Parental acceptance is similar to that with rotary instrumentation, although many appear pleased that their children are more relaxed and less apprehensive under ultrasonic instrumentation. By and large, they take the position that they want the work accomplished as rapidly as possible, by whatever means the operator deems most suitable and with a minimum of disturbance to them.

Three of the total of 109 patients in Phases One and Two preferred to return to rotary instruments for future operative dentistry. The remainder, or 106, constituting more than 97% of the total number of patients treated in this group, expressed a distinct preference for the ultrasonic dental unit.

Reduction in Use of Anesthesia

Of the thirteen patients on whom both rotary and ultrasonic instruments were used, nine required anesthesia for rotary preparation and one required anesthesia for ultrasonic preparation.

Of the total of 109 patients whose teeth were prepared with the ultrasonic dental unit, in these two phases of the study, two required anesthesia before it was possible to complete the preparations with the ultrasonic dental unit, and two others required anesthesia in order that the preparations could be completed with rotary instruments. Thus, four patients, or approximately 3½% of the total covered, required anesthesia under ultrasonic dental preparation.

Increase in Number of Operative Procedures, Measured by Surfaces Worked, per Sitting with Ultrasonics

The trauma-free cutting action of the ultrasonic dental unit apparently makes it possible for the child patient to accept

more dentistry per sitting than is the case with rotary instruments.

This was demonstrated frequently when it was necessary, for one reason or another, to complete a large amount of work in one sitting. In some special cases, parents bring their children to Miami from the Caribbean Islands or other surrounding areas and wish to have all the necessary dental work completed as soon as possible. In other instances it is advantageous for the operator to be able to complete the necessary work in one sitting when he knows—from the patient's previous history—that it is difficult to make the patient return as scheduled for additional appointments for necessary work.

We have discovered that in some instances, the number of surfaces which can be completed—due to the relaxed, cooperative behavior of the child—is limited only by the economics of the situation. By this is meant that sometimes parents will balk at paying what appears to them to be an inordinately high fee for a given amount of time, regardless of the fact that more than the usual amount of work was accomplished.

In one unusual case, eleven preparations were completed on the permanent teeth of a 15 year old girl in one hour and forty minutes. These included five occlusal preparations, three MO's, and three DO's. No anesthesia was used and the child continued to be thoroughly relaxed throughout the operative procedure. No unusual post-operative symptoms have been reported since treatment on December 15, 1955.

In another instance, two sisters, ages 9 and 13, were treated the same day. The 13-year old had eight preparations in permanent teeth which included 4 MOD's, 1 MO, 1 DO and 2 simple occlusals. Her sister, aged 9, had ten one surface cavities prepared. These included two linguals, three buccals, two occlusals and three proximals. The proximals were prepared on the mesial surfaces of first permanent molars which were readily accessible due to unerupted second bicuspids.

No anesthesia was used on either of the girls and no unusual post-operative symptoms were reported or observed.

Operating Speed and Technics

The chair time necessary for the completion of cavity preparation with the ultrasonic dental unit is comparable to or less than required in rotary instrumentation. Actual speed of operation is comparable with, as regards cutting time, carbide or diamond instruments. There is no difficulty in cutting any type of angle in any portion of the cavity preparation and the finished margins need less final finishing than is usually the case after rotary instrumentation.

Cavity preparation can be accomplished by the uninitiated operator who is already accustomed to working with rotary instruments, with no additional or special training in the use of the ultrasonic dental unit. However, an extremely light touch is needed in order to obtain optimum operating efficiency with this instrument. The handpiece itself weighs approximately six ounces and optimum working pressures range from two to five ounces, or considerably less than the weight of the handpiece.

The operator retains complete tactile control at all times with no distortion of the type customary with the rotary instruments as a result of rotational torque.

The only habit which must, in a sense, be "unlearned" is that of using the pressures which are routine with rotary instruments. The requisite gentle, light pressure can be readily discovered and mastered if the operator will practice initially on

extracted teeth, glass or hard plastic. It must be understood that the instrument will not cut efficiently at heavy pressures and will, as with rotary instruments, create heat when too much pressure is applied.

Excess pressure will prevent the water-abrasive mixture of cutting compound from coming between the instrument tip and the tooth, resulting in inefficient cutting or a cessation of cutting. At the same time, cessation of this liquid flow will deprive the instrument of the necessary cooling, and the tooth will heat up due to surface friction. With the instrument vibrating 29,000 times per second, back and forth with a reciprocal stroke of 0.0014 of an inch, considerable friction can develop if excess pressure damps the vibration or prevents the proper flow of water-abrasive cutting compound and coolant.

As with any new piece of equipment or instrument, some personal adaptation must be made by the operator in learning its use.

Operating spaces available in most dental offices are adequate for the addition of this instrument without crowding. Use of auxiliary personnel, in handling the suction apparatus, increases operating efficiency as it does with other instruments. Care of the ultrasonic dental unit may be delegated to auxiliary personnel, just as routine care of rotary engines and handpieces is now delegated to them.

The model in use during this study was the early investigative model 200, which has since been superseded by a newer commercial model 210.

Summary of Phases One and Two

1. The use of the ultrasonic dental unit for cavity preparation shows no clinical evidence of abnormality or pathology in operated primary or permanent teeth, or upon unerupted permanent teeth developing in areas of operated primary teeth, as can be determined by radiograph and routine clinical follow-up examinations carried out six months after date of operation.

2. Patient acceptance of this new instrument in a pedodontic practice is uniformly high, except in some very young patients affected by gagging or disturbed by the need for additional equipment (saliva ejector, etc.).

3. The dentist can now offer his patients increased comfort for operative dentistry without the use of anesthesia.

4. The high level of patient acceptance and the operator's ability to work without anesthesia, because of the relaxed condition of the patient, makes it possible for the operator to complete a significantly larger number of surfaces or other operative procedures per unit of chair time with the ultrasonic dental unit than has heretofore been possible with rotary instruments.

5. Since the ultrasonic dental handpiece cannot cut soft tissue while in operation, the dentist is free of the traditional fear of injuring his patient. Both patient and dentist are more relaxed because of this knowledge.

6. The dentist may use the ultrasonic dental unit without additional or special training and can perform any operative procedures now performed with conventional instruments once he has developed the light tactile sense necessary for optimum operation of the ultrasonic dental unit.

Phase Three

Pulp-test and Radiographic Follow-up on Limited Number of Orthodontically Condemned Teeth

A group of twelve patients included in this phase of the study consists of clinic patients specifically chosen because as

orthodontic cases, they were each scheduled to have from one to four teeth extracted. Only those patients were chosen whose condemned teeth were free of previous operative work or other involvement.

In all, 38 teeth were selected for observation. Seven of these were prepared with diamond instruments which operated at approximately 15,000 R.P.M. Twenty-five were prepared with the ultrasonic dental unit and six were chosen as controls.

Where four bicuspids were available in one patient, one tooth was selected as a control, one tooth chosen for rotary preparation with diamond instruments and the remaining two prepared with the ultrasonic dental unit. Five such cases are included in the study, two boys and three girls ranging 10½ to 14 years of age.

Among the 25 ultrasonically prepared teeth, three were primary, including the upper right and left primary cuspids in one patient, and the upper right primary cuspid of a second patient, both girls, age 13.

Five of the six control teeth were upper left first bicuspids, the other a lower left first bicuspid. Three of the teeth prepared with rotary instruments were upper left first bicuspids, one upper right first bicuspid, one upper right second bicuspid, one lower right first bicuspid, and one lower left first bicuspid.

Among the teeth prepared with the ultrasonic dental unit, there were three upper left first bicuspids, nine upper right first bicuspids, one upper right second molar, one lower left first bicuspid, one upper left second bicuspid, six lower right first bicuspids and one lower right second bicuspid.

Simple Class I occlusal cavities were completed in all the prepared teeth and the cavities filled with zinc oxide and eugenol. The depth of the cavities varied from 1.5 mm. to purposeful exposures in five teeth, including two prepared with rotary instruments and three prepared with the ultrasonic dental unit.

Periapical radiographs, pulp and thermal tests supplemented the general clinical observations made before each preparation, immediately after each preparation, and then in successive intervals of from one to two weeks until the time for extraction of the individual teeth. Upon extraction, the teeth were placed in 10% formalin and readied for sectioning.

The information obtained from histologic study of these sectioned teeth, when combined with the post-operative data compiled on each tooth, will complete this third phase of our initial report.

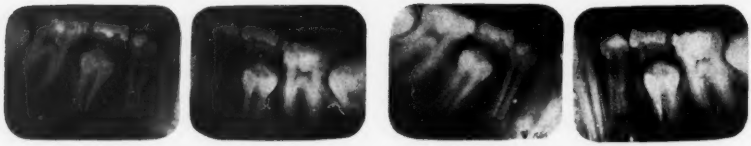
Methods Employed

A high frequency vitalometer (electric pulp tester) was used to observe the sensitivity changes in the teeth under observation and to determine, within the limits of this form of diagnosis, the continued vitality or non-vitality of the teeth. Thermal tests were made routinely at each examination.

Heat was applied by use of hot gutta percha, which was touched to the buccal surfaces of the teeth tested. Cold tests were conducted with the use of ethyl chloride spray on cotton rolls applied to the buccal surfaces.

Prior to conducting the pulp tests, a dab of tooth paste was applied to both lingual and buccal surfaces of the teeth studied. The unipolar terminal was then placed on the sound enamel surface nearest the gingiva, depending upon the extent of eruption of each individual tooth. Current was gradually increased and when the initial patient response occurred, the dial readings were noted. Three dis-

LR 10/27/55 (prior to prep.) | LL 10/27/55 (prior to prep.) | LR 11/4/55 (post-operative) | LL 11/4/55 (post-operative)



LR 11/9/55 (post-operative) | LL 11/9/55 (post-operative) | LR 11/16/55 (post-operative) | LL 11/16/55 (post-operative)

FIG. 3. Radiographic follow-up of condemned first bicuspids prepared ultrasonically 10/27/55

tinct readings were taken for each surface, buccal and lingual, and the average reading recorded.

DISCUSSION OF FINDINGS

The dental literature amply illustrates the limitations of the electric pulp tester in providing fine discriminative data on tooth vitality as measured by its sensitivity to electrical stimulation. However, in this study we were primarily concerned with its use to obtain gross information as to the vitality or non-vitality of the teeth, cognizant at the same time that in some instances the pulp tester will not even provide the correct answer to this question.

In each case reported, repeated readings indicated the continued vitality of the teeth concerned (see Figure 2).

The radiographic findings were uniformly negative, showing no signs of abnormality in the operated teeth, their supporting structures or in the permanent teeth beneath the primary teeth prepared. Findings were similarly negative as regards the surrounding bone structure and periodontal membrane (see Figure 3).

These findings are reported with the knowledge of the limitations of radiographic examination. Obviously it cannot provide complete information as to the bacteriological or pathological condition of the tooth. However, within the limits of post-operative examination as defined by the limits of diagnostic tests conducted, the observed teeth showed no signs of abnormality or unusual post-operative sequelae.

The histological study which will complete this phase of the project will supply the final data and will serve either to corroborate or contradict the clinical findings here reported.

Figure 3 shows the results of an eight week radiographic study on one representative tooth of the study, a first bicuspid in a 10 year old male child.

Of the 31 teeth prepared upon 14 patients, either with rotary instruments or with the ultrasonic dental unit, anesthesia was required on one patient on whom two

teeth were prepared with the ultrasonic dental unit. Her dental history shows extreme sensitivity and the use of anesthesia in all previous rotary prepared teeth. In the pulp tests on this case, the minimal electrical stimulation was required to provide a measurable response. This case reported her preference for rotary instruments. The remaining thirteen cases strongly indicated their preference for the ultrasonic dental unit for future cavity preparation.

Brief Summary of Three Phase Study

1. Study includes 123 patients of both sexes, ranging from 3½ to 15 years of age. It extends in time from February 2, 1955 to January 10, 1956.

2. Total of 437 teeth were observed, prepared, including 51 teeth prepared with rotary instruments and 380 teeth prepared with the ultrasonic dental unit. In all there were 283 permanent teeth and 148 primary teeth prepared and six teeth used as controls.

3. Study was divided into three phases, each providing for a different degree of post-operative follow up.

a. Phase 1 provided for routine clinical examination and bite-wing radiographs taken six months after preparations were completed. This covered 24 patients and 140 teeth. Radiographs and clinical follow-up revealed no unusual post operative symptoms. There was no evidence of abnormality of developing permanent teeth or their surrounding structures, nor of supporting structures of operated teeth.

b. Phase 2 provided for routine post-operative clinical examination short of six-month period, and without radiographs. This group included 85 patients and 259 teeth. No unusual post-operative symptoms reported.

c. Phase 3 provided for extensive post-operative examination including radiographs, pulp and thermal tests, on previously uninvolved teeth condemned for orthodontic purposes. Upon extraction, at different time intervals up to two months after preparation, the teeth are to be sectioned for histological study. This group includes 14 patients and 38 teeth, seven of which were prepared with diamond instruments, 25 prepared with the ultrasonic dental unit and six chosen as controls.

Radiographs, pulp and thermal tests, taken every six to eight days until extraction, indicated the continued vitality of all teeth studied with no signs of abnormality in operated teeth, or developing permanent teeth and supporting structures.

4. Patient acceptance was uniformly high for ultrasonically prepared teeth.

On 123 patients on whom 380 teeth were prepared ultrasonically, five patients required anesthesia.

On twenty patients on whom 57 rotary preparations were completed, ten patients required anesthesia.

On the 20 patients upon whom both rotary and ultrasonic preparations were completed, one required anesthesia for ultrasonic preparation. Of the same 20 patients, ten required anesthesia for rotary preparation.

Of the total of 123 patients treated, four expressed the desire to return to rotary instruments for future dental work. The remainder, a total of 119, reported a distinct preference for the ultrasonic dental unit.

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THE AMERICAN SOCIETY OF DENTISTRY FOR CHILDREN

APPLICATION FOR MEMBERSHIP

I am interested in becoming a member of the American Society of Dentistry for Children.

NAME.....DEGREE.....

ADDRESS.....

.....

If you are a dentist or physician, you must be a member in good standing of your local dental or medical Society.

If you wish associate membership, please indicate affiliate society membership.

Send this application to:

American Society of Dentistry for Children
Mt. Royal and Guilford Avenues
Baltimore 2, Maryland

Practical Pedodontic Practice*

EDWARD S. MACK, D.D.S.

POSSIBLY it has escaped the attention of many dentists—certainly it has escaped the attention of most of the dental training centers, but there is a lot of truth in the following:

The professional ability, the personality of the dentist, and his ability of patient management, are not the entire key to success in a dental practice. Of course, they are very important factors. However, there are two factors which are so important that they completely balance the entire value of the aforementioned three (Fig. 1). They are the location of the dental practice, and the business methods used in that practice, in the handling of patients. In this paper the author would like to deal with some of the following questions:

1. Where should the new dentist locate his office? In town, in the suburbs, or in the country?

2. How shall he decorate it? Should it have a style, a theme, or a motif? Had he better not make it too lavish?

3. What is meant by business methods? Attractive fees? A budget plan? Pay-as-you-go system? Or should one have some special accounting fol-de-rol?

These questions will be at least partially answered in this paper.

Whether or not the dentist chooses a lovely bungalow setup or a larger group bungalow setup, or chooses a large metropolitan office building—or perhaps even one of the large skyscrapers that he may find in the downtown of a large metropolitan area, the important thing to consider is this: that a good office location is one of the prime essentials to the success of a practice.

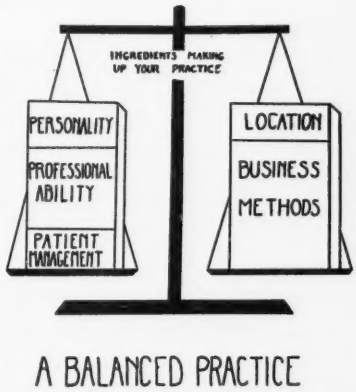


FIG. 1. Demonstrating the equality of importance of office location and business methods, as weighed against the factors of the dentist's personality, the dentist's professional ability, and his ability to handle and manage patients.

This is almost as true on the professional level as it is in most businesses. It has been shown in several studies, that, of businesses that failed, 20% had poor locations, and it should be realized that the same basic factors that influence choice of business locations should impress the dentist when choosing a practice site. Any practice or business location is continually reflecting the economic and social conditions of its environment. A good location today might be a hazardous choice tomorrow. Also, it should be considered that a good business location does not necessarily mean that a professional office would be similarly successful in such a place. However, certain patterns are worthy of thought. A good rule of

* Presented at the National Meeting of the A.S.D.C., San Francisco, California, October 1955.

thumb is to choose an area where the dentist to the public ratio is about 1 to 1,000. Beware of the locations where the dentist ratio is remarkably low. For example, 1 to 3,000 or also where it is quite high, such as in a community already overloaded with professional service.

On the one hand, the former, the low ratio area may indicate a serious low status of culture, education, and economic factors. While the latter, may indicate an oversupply of available dental services to an already surfeited populace.

One good method of checking on a proposed location—for instance in a suburban community a few miles from an urban center—is to locate circulation figures of local newspapers. It has been said that if a newspaper shows 100,000 circulation, a dentist can hope for 1% as prospective patients. If the population of a town shows a sudden population growth, it should be surveyed in order to determine whether this growth indicates a temporary boom, or growth on a more substantial basis. It is wise to investigate the general earning power of a community. The rates of rentals have been accepted as a fairly reliable guide. The ratio is something like this:

If a man pays $75 monthly rent, it may be assumed that this represents ⅕ of his monthly income, or an earning of $375 monthly. Translated to yearly figures, this represents an annual income of $4500. Now, according to government statistics, 3½ per cent of income is about what a man spends for medical services. So our man could expect to spend roughly $157 yearly for medical care. With 5,000 such people in a town, an aggregate of $785,000 would be spent. This figure could be divided by the total number of medical and dental practitioners in town. For instance, the medical and dental practitioners of the community totaled 50. Then it could be assumed that the average practitioner would gross about $15,000 yearly. It should be remembered that professional men are not necessarily competing for available purchasing power of the community. Competition is largely restricted to businesses. Whereas style items and luxury items boast a multi-billion dollar market, dentistry is confined to but a fraction of such total expenditure. In general, the author suggests the new dentist answer the following questions to himself before planning to open a dental office in a given community:

1. Are the average families well established?
2. Could the area use another dentist?
3. Are the people generally of a type to demand good dental service?
4. Is the area healthily growing?
5. Are good transportation facilities available?
6. What is the existing scale of dental fees in this community?
7. In the community, is income dependent on seasonal factors?
8. Would the working hours of the people or the practicing hours of the existing dentists necessitate evening working hours?

Now, when the new dentist opens his office, from where should he assume his practice is to come? It should be noted that the patients nourishing the budding practice are drawn from the following:

1. Relatives and friends of the new dentist.
2. People he gets to know from his business transactions.
3. People looking for another dentist more conveniently located than their former dentist.
4. Newcomers to the area.
5. People who are dissatisfied with their previous dentist.
6. Transients.

FIG. 2. A notice informing parents of an important office policy. It is placed conspicuously in the reception room. It reads, "Parents Are Requested to Remain in Reception Room Except During Consultation". (Courtesy: Francis W. Summers, D.D.S.)

THE ATTRACTIVE OFFICE

Like in so many other human endeavors, people are attracted to that which is clean, neat, functional, and charming. When the dentist is catering to children, the taste of the child as well as the taste of the parent must be considered.

In the reception room a children's corner may be effective. These following illustrations are taken from various offices in the San Francisco Bay Area to demonstrate certain useful ideas. Many dentists use motifs. That is, a central theme about which the office can be decorated. For children, the total motifs available are generally of two main classes: one, a western or cowboy theme and the other a theme dealing with animals and children such as a circus motif, nursery rhymes, and so on. An aquarium may be placed in the reception room. Moving fish provide an endless source of amusement and interest to the child patient, and a means of entertaining children while waiting for their dental appointment.

Perhaps a good thing to have on the door of the reception room leading to the inner office is a statement of policy of the office. Figure 2 illustrates such a sign on the doorway of the reception room leading into the foyer of the inner office, which states: "Parents are requested to remain in the reception room except during consultation." In this terse message a major policy of the office is expressed. It tells the parents exactly what to expect as far as the dental-parent relation-

ship is concerned. If the parent asks for an explanation of why she was not immediately invited into the office, it can be explained simply and pleasantly, that the reason is that the dentist wants to make friends with Mary. As long as mother is present, Mary will not communicate directly with the dentist. She would deal with him through Mother. That is the reason for the sign.

Another way to make children feel welcome is to have a toy chest (Fig. 3) from which a child can take his choice of any inexpensive toy upon the leaving of the dental office. It is to be used only as a gesture of friendship and not as a bribe.

A little subdued music in the background of the dental office does a lot of good. It removes the dead silence and

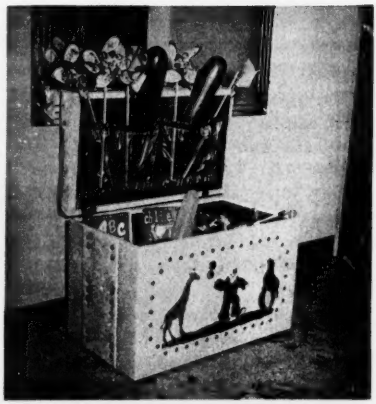


FIG. 3. The Toy Chest: a source of never ending delight for children.

FIG. 4. A corner devoted to dental health education. (Note: Carbonated beverages shown here, are sugar-free.) (Courtesy: Charles A. Sweet Jr., D.D.S.)

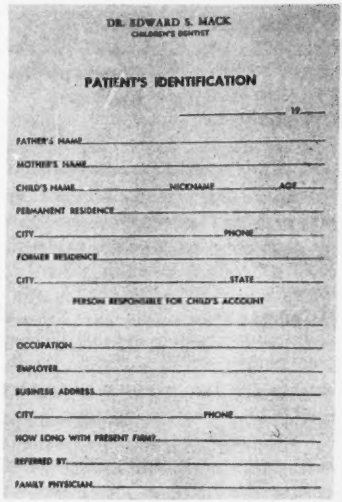
puts many people at ease. The therapeutic value in the reception room for overanxious parents waiting for their children is immense. By all means it should be considered when opening or improving an office.

Perhaps a good suggestion is that the operating rooms themselves be decorated to make them more appealing to children. Murals on the walls have a peculiar appeal to children. Tasteful dental murals which are colorful, and yet have a strong dental flavor, can be a great source of patient education while the patient is being treated.

As well as decorating the office with a motif or with certain color schemes, many dentists have donated a section of their office to dental health education. Some dentists have a sink for the children, where they can practice tooth-brush drills—often when the parent is actually able to witness the procedure. Dental health education can also be expressed by a demonstration of the warning of excessive sweets, with a little setup used for such dental patient education (Fig. 4).

The Business Office

It has long been known that the nurse or secretary should have an adequate station, or place where she can carry on appointment bookings, her dealings over the telephone, the payment transactions, and general bookkeeping. The dentist can have a large desk or perhaps a more intimate one. A point to remember is that even a small business office should look like a business office—one designed for keeping accurate records. This implies that the business aspect of the office is being carried on in a proper, businesslike manner, and that therefore the patient will assume that the bookkeeping will probably be correct, and not suspect to question.



DR. EDWARD S. MACK
CHILDREN'S DENTIST

PATIENT'S IDENTIFICATION

_____ 19____

FATHER'S NAME _____

MOTHER'S NAME _____

CHILD'S NAME _____ NICKNAME _____ AGE _____

PERMANENT RESIDENCE _____

CITY _____ PHONE _____

FORMER RESIDENCE _____

CITY _____ STATE _____

PERSON RESPONSIBLE FOR CHILD'S ACCOUNT

_____

OCCUPATION _____

EMPLOYER _____

BUSINESS ADDRESS _____

CITY _____ PHONE _____

HOW LONG WITH PRESENT FIRM? _____

REFERRED BY _____

FAMILY PHYSICIAN _____

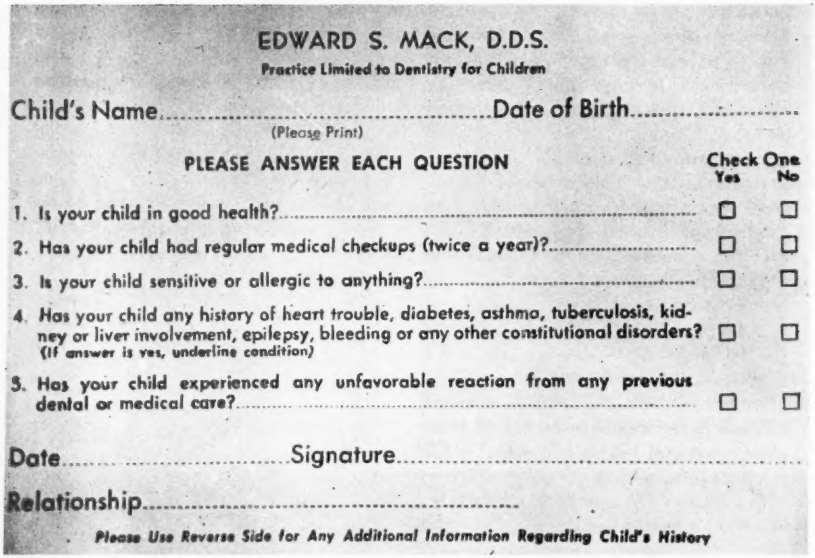
Fig. 5. An example of a form to be filled out by child's parent at the first appointment.

Patient Identification Information

One of the best means of patient introduction is to have the parent fill out forms such as the ones illustrated (Figs. 5 and 6). These forms can be presented on a clipboard with a sharp pencil for the parent to fill in while still in the reception room. The identification form reads as follows:

1. The patient's name.
2. The mother's name.
3. The father's name.
4. The child's nickname.
5. The age of the child.
6. The permanent residence, the city, the telephone number.
7. The former residence, city and state.

It should be noted that an excellent way to trace people in case they prove unreliable is through the former residence. Many times a person keeps in communication with his family and



EDWARD S. MACK, D.D.S.

Practice Limited to Dentistry for Children

Child's Name.....Date of Birth.....

(Please Print)

PLEASE ANSWER EACH QUESTION	Check One Yes	No
1. Is your child in good health?	☐	☐
2. Has your child had regular medical checkups (twice a year)?	☐	☐
3. Is your child sensitive or allergic to anything?	☐	☐
4. Has your child any history of heart trouble, diabetes, asthma, tuberculosis, kidney or liver involvement, epilepsy, bleeding or any other constitutional disorders? (If answer is yes, underline condition)	☐	☐
5. Has your child experienced any unfavorable reaction from any previous dental or medical care?	☐	☐

Date.....Signature.....

Relationship.....

Please Use Reverse Side for Any Additional Information Regarding Child's History

FIG. 6. An example of a medical information form to be filled out by child's parent at the first appointment.

friends where he formerly resided. In the next heading:

8. The person responsible for the child's account.
9. The occupation of that person.
10. His employer.
11. Business address, city.
12. Telephone number.
13. How long with the present firm.
14. By whom the parent was referred.
15. Family physician.

Much of this information, if not obtained on the first appointment, becomes difficult to obtain later, after friendships have been established. This information should be procured on the initial appointment of the patient. The following is also given with the identification form. It is a health form and gives the parent a chance to explain to the dentist the health status of the child (Fig. 6).

The child's name is printed.

The date of the birth of the child is to be filled in, and then a request to please answer each question.

1. Is your child in good health—yes or no?

2. Has your child had regular medical checkups twice a year—yes or no?

3. Is your child sensitive or allergic to anything—yes or no?

4. Has your child any history of heart trouble, diabetes, asthma, tuberculosis, kidney or liver involvements, epilepsy, bleeding or other constitutional disorders—yes or no? If the answer is yes, please underline the condition.

5. Has your child experienced any unfavorable reaction to previous medical or dental care?

This last question will give the dentist insight into the psychological status of

the child. It is followed by the date, the signature of the person filling out the card and the relationship of that person. One may use the reverse side for any additional information regarding the child's history. It is remarkable how much key information is picked up on these cards. And conversely, how hazardously the dentist carries on his practice if he does not obtain such information from the parent beforehand.

The Consultation Room

Perhaps the most important question the dentist should ask himself, is whether his office warrants a consultation room and why doesn't it have one if it does?

It has often been said by a parent—we have heard many times a serious mother say something like this:

"Oh, gee!, Doctor, I'd rather go through having a baby than go to the dentist."

It's an old saying. But sometimes we forget that the parent may mean exactly what she is saying. Here is being expressed a *tremendous fear* of the dentist. It should be borne in mind that a dental operating room to many persons is a fearful place. Hence any conversation in a dental operatory, no matter how beautifully that room may be decorated, is obscured by the anxieties of such a disturbed person. To such a person the room is no more than a surgical room—a place where fears are expressed, pains are felt, and blood may be let. It makes as little sense for such a parent to try to concentrate on what the doctor is saying as it does to have some important word spoken by the physician while in a hospital operating room before the removal of a gall bladder or some other major medical procedure whilst that person awaits the gas mask. The place to discuss cases—the place to free the parents' mind from immediate concern, so that they can listen to the dentist without distraction is in a consultation room. This room is best designed purposely not to look like a part of the routine dental office.

The Consultation

It should be noted that a consultation means exactly what it says. It means that the parties concerned are sitting about and discussing freely the matter before them. An adequate consultation, of course, cannot be a few off-hand remarks made in the operating room. In fact, it cannot be a few off-hand remarks made anywhere. It is a carefully prepared diagnosis with an expression toward treatment planning, and with the arrival of a just fee for the services rendered. It is preferably not given on the first visit, but at a subsequent visit, when perhaps both mother and father can come in without the child. It is almost never a few brief words, followed by a quickly placed restoration in a tooth of the child, during that same visit.

Procedure with a New Patient

Let us take a child and parent from the initial telephone contact up to the restoration of the first carious tooth in a suggested routine.

Initially, the telephone should be picked up by a competent, cheerful-sounding secretary. A suggestion here might be in order: A secretary should never, or almost never, pick up a telephone and merely coldly call back a telephone number, as this is often irritating to the person on the other end of the line. Besides, it delays the whole conversation. The only logical justification that can be found for calling back a telephone number is in a multiple practice set-up where there is a series of many names

which would have to be called back on the telephone. In only such an instance, it might be briefer to call back simply a number. Ordinarily the secretary should cheerfully say, "Dr. Jones' office. May I help you?" and, as she receives the essential information over the telephone, she should place it in the appointment book and should write the patient's telephone number following that patient's name, with an indication that this patient is a new patient. Incidentally, generally it is a good idea to indicate briefly the work to be done after the patient's name in the appointment book.

Sometimes an inquiring parent may open the conversation on the telephone in this manner:

"How much does Doctor charge for a filling?"

The secretary should state that she really doesn't know, but that she would be very happy to call the dentist to the telephone to answer such a question. However, in many offices, the dentist may establish a policy that he is not to be called to the telephone for such a matter. However, if he does decide to speak to this person, the best answer the author knows goes something like this:

"I have no fee per filling. The cost is dependent upon the size of the cavity and the response of the child. Sometimes I may fill two or three small cavities for four or five dollars, and at times charge that much for one."

This reveals two obvious facts to the parent:

1. That if the child is seen regularly, cavities are smaller and the fee is less.

2. That the better Mary's behavior, the less the cost.

When the parent and child arrive for the first appointment, the child is never kept waiting long in the reception room. As soon as practicable, the nurse escorts the child into the operatory. Meanwhile, the parent is handed a pencil and a clipboard on which the afore-mentioned forms are attached, so that the parent can fill out those forms. In the operatory, the doctor, as soon as possible, cursorily examines and makes friends with the child. The parent is soon brought into the operatory and introduced to the dentist. The dentist should then speak to the parent and ask if she has any questions pertaining to the child's teeth, or if any tooth is bothering the child. The dentist may then point out a few obvious conditions in the mouth which bear further investigation, and may say something like the following:

"Mrs. Jones, since nothing is bothering Mary today, I would like to thoroughly examine her teeth, clean them, and take some x-rays to see if any other conditions are disclosed like this big cavity right here. The x-rays will also show me the extent of decay in this tooth."

The mother is usually quite agreeable, and it is then suggested that the mother leave the room. The dentist then proceeds to do as he promised. After the x-rays have been developed and the examination and prophylaxis completed, the mother returns to the operatory and the dentist proceeds to enumerate some of his findings, and says something like this:

"Mrs. Jones, Mary has several other areas which I found while cleaning and examining her teeth and by means of the x-rays. After these x-rays are dried, I would like to go over them very thoroughly. I think a good suggestion would be to see you and Mr. Jones before Mary's first appointment. Would it be possible for you and Mr. Jones to come in soon without Mary, so I could discuss with you in detail my findings, as to the work to be done, certain growth and development factors, and my plan of ap-

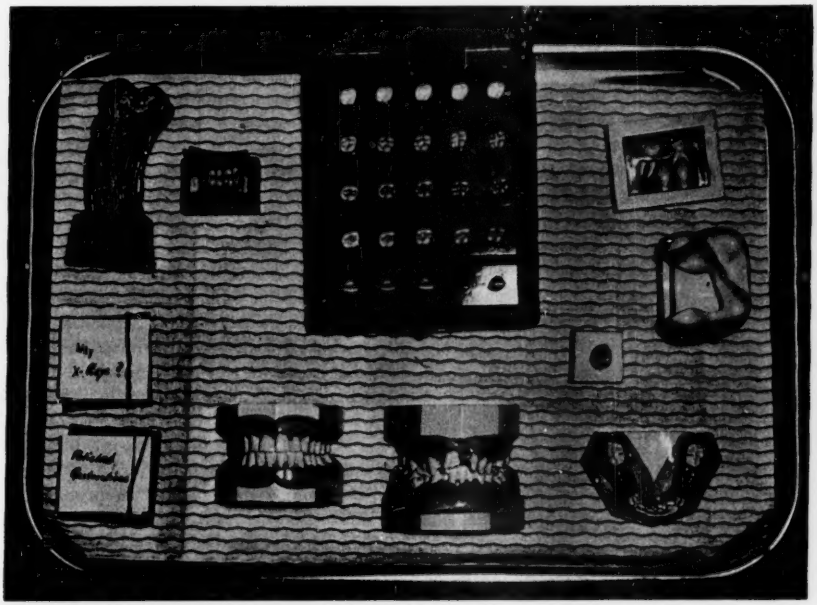


FIG. 7. An example of demonstration models placed upon the "consultation tray".

proach. I would also like to show you her x-rays magnified considerably, so that you can see these conditions as well as I can."

The mother then makes an appointment for the child, and promises to call in to make an appointment for a consultation whenever it is convenient for the father.

When the mother, father, and the dentist sit down, and discuss the problems that they have to face, such as the child's tendency to dental decay, or former unhappy experiences of the child with a dentist, etc., a better exchange of thoughts can be established. This is the dentist's opportunity to educate both parents as to growth and development factors: how a permanent 2nd bicuspid can become impacted due to the premature loss of a 2nd primary molar, and so on. It is at such a moment that the parents are in a psychological frame of mind to be more thoroughly educated than they are at most any other time. Their very presence indicates they desire to be helped. Although the financial arrangements are also a part of the consultation, it is never the prime object of the consultation, and the dentist never handles the actual mechanics of financial arrangements himself. This is best done by his secretary. The dentist's job is to educate, and his is the responsibility to tell parents the complete dental story.

Figure 7 is a view of the consultation tray used in the author's office. This tray is usually placed on the dentist's desk,

and covered with a towel prior to the entrance of the parents into the consultation room. It consists of a slide demonstrating the value of x-rays; it has a model of a normal dentition and a model of a dentition which is the end result of neglect of the primary teeth. A space maintainer on a model is also on the tray, as well as some examples of restored teeth. In other words, the consultation tray contains those items which are necessary to educate the parent to the necessity of pedodontics. Toward the close of the consultation, the dentist should inform the parents of his treatment plan, and quote the fees for these services.

Some Suggestions

1. At the conclusion of the consultation, the dentist has his secretary enter the room. He says something like this, "Mr. and Mrs. Jones, my secretary Miss Smith will confirm Mary's next appointment in the appointment book and also will explain to you how your account may be handled." He then asks if there are further questions, and if there are none, he leaves the room and returns to his work.

2. During the consultation is the ideal opportunity of the dentist not to overpromise results as to what he can do for the patient.

3. The dentist should keep in mind that it has been the history of the average dental office to lose 32% of the accounts collectable. In other words, the dentist collects about 68% of his accounts—this information is the result of a survey prior to 1947; with the continued "good times" of the last few years, it probably paints too black a picture. Nevertheless, the dentist should have a good, accurate bookkeeping system and thus help maintain fair fees.

4. It is wise for the dentist to keep in his checking account at the bank a cash reserve equivalent to two months' cash income, and so be free of financial worry.

5. In the appointment book, the dentist should make a notation with red pencil every time a new patient contacts his office. In this manner he has a good means of checking the practice growth.

6. He should not compare his gross receipts from month to succeeding month in order to determine practice growth. He should realize that all calendar months are not the same: that is, dentistry is somewhat cyclical. Only by measuring a March to March, or an October to an October, can he have a more accurate yardstick of growth.

7. When quoting fees, it is a good idea to mention to the parent several different types of approach as to how the problem of little Mary's mouth can be treated, rather than presenting one treatment plan with one fee and that is all, leaving the parent with the attitude of "take it or leave it."

8. Monthly statements should be sent regularly and promptly. They should arrive at the homes of the parents promptly on the first of the month. The system on budget accounts should be so arranged that reminders are sent out promptly when the account is past due.

9. By all means, have a good recall system in the office. This is healthy for the continued growth of the practice, and places responsibility on the parent. If they do not keep the recall appointment and the child has resulting dental problems, at least the dentist has fulfilled his responsibility.

10. All silver amalgam restorations should be finished and polished.

11. The dentist should not present a fee until a diagnosis is complete.

12. The dentist should not discuss a fee with parents until they are fully relaxed

and concentrating on what the dentist is saying.

13. The dentist should not discuss fees with a patient who lacks confidence in that dentist.

14. The dentist should not proceed with a case unless the parent has a complete understanding of the fees and a schedule of payments.

15. When it becomes necessary to reduce a fee for a needy person, it should be handled in a definite way. One nice way is for the dentist to ask the person needing help, if it is permissible to telephone the person who referred him and inform the referring party of his intentions of offering a special discount. In this way, the office will not acquire the reputation of being a "two fee office."

16. Professional courtesies as far as discounting is concerned, should be done by a definite pattern. Such and such a per cent off for the children of medical practitioners, such and such a per cent off for other dentists, such and such a per cent off for pharmacists, such and such a per cent off for nurses, close friends, and so on. It is wise to have these things well thought out ahead of time, so there is no worry about each new similar instance.

17. The dentist should not overcharge any patient. He should base his fees on his skill, the responsibility of the service, and its contingencies. He should base them on the actual cost of operation.

18. He should not add any charges to the original fee after that fee has been quoted, without informing the parent that the original course of treatment is changed, and why the additional charge has been made.

19. He should not discuss fees with a minor under any circumstances. He should inform the parent, guardian, or others responsible for payment. He should help them understand the diagnosis, and the work involved.

20. He should not discuss fees with the patient who depends on somebody else for the final decision. By all means he should suggest that this consultant be invited to discuss his findings, and then quote the fee.

21. In quoting fees for any prosthetic service, he should not in his discussion, base the fee, or imply that any fee, will be based on materials or laboratory charges. He should be firm, fair, and friendly.

22. Pay-as-you-go is dynamite! There is no more effective way of ruining a dental practice than to have people routinely go on a pay-as-you-go plan. This enforces a constant itemization of the dentistry being done, and implies that the dentist is running a cash-register, rather than a professional type of practice. The dentist's hands "become tied" with such arrangements! For instance, if he has given a mandibular block anesthetic, he cannot go ahead and do a full quadrant of the mouth at one sitting, because the charges for this appointment might appear prohibitive to the parent. So therefore he has to do one or two restorations at the most, per visit. Also, the dentist will find himself with an appointment book full of broken appointments, because if the parent that particular day is unable to bring the few dollars that she feels is expected of her, then very often, a slight excuse is sufficient for the parent to call and break the appointment. That is why a calendar budget plan is such an excellent solution; since it divorces the payments from the service. The dentist is now free to finish the dentistry as soon as possible, and with as little inconvenience as possible to the child and the parent.

Cavity Counting

Figure 8 illustrates one of the more common pitfalls in everyday dental practice. The author calls it "cavity counting."

For some peculiar reason, many parents feel that by the dentist telling them the number of cavities in a child's mouth, they, the parents, get a complete picture of the dental service being done. This can be quite far from the actual truth. It takes but little skill on the part of a person to divide the number of cavities into a fee, and come out with a figure which can be assumed is to be what the dentist charges for "fillings." As a matter of fact, the opinions of many dental practitioners will differ, one from another, according to their evaluation of which cavities should be treated, how they should be treated, whether pulpotomies are necessary, the psychological approach to the child, and so on. Certainly, it is not simply reduced to a number which can be presented to a parent as the total story. As a matter of fact, this "cavity counting" is a good guide to the failure of a dental practice. That is, if the dentist is asked quite frequently, "How many cavities does my child have?", it is a good indication that many parents are seeking some means of comparing this dentist with other practitioners. It demonstrates a lack of confidence in that dentist!

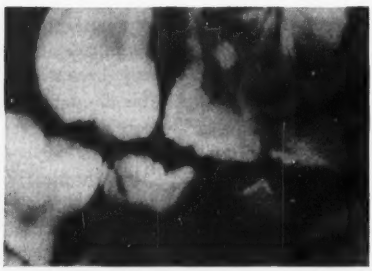


Fig. 8. "Cavity counting" is a very misleading method of determining the value of a dental service. How many cavities does this x-ray show? A blunt answer to this question hardly begins to indicate the conditions to be considered. Different practitioners examining such a film, will evaluate it in various ways. The parent, who simply desires to divide the number of cavities into the total fee, hardly has a concept of the necessary dental health service involved.

In closing, it may be mentioned that it is common knowledge, that people, when dealing with politics and medical health services, do not want what they cannot understand. Frankly, the author seldom blames them.!

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Editor's note:

Reading the accompanying article several times during the process of its preparation for publication, your Editor is impressed with the wealth of good common sense it presents.

For the young man starting out in practice or for the older man who wishes to refresh his thinking and perhaps evaluate his office procedures, this paper by Ed Mack is recommended reading.

Appearing as it does, toward the end of the Senior year in our dental schools, it is excellent library reading assignment material. We suggest you keep this issue of the Journal and give it to that 1956 graduate who may ask your advice about his plans for the future.

A. E. S.

Unit News

SOUTHERN CALIFORNIA

5th Annual Postgraduate Conference, Ojai Valley Lodge

March 20 to March 23, 1956

The world authority on physical anthropology, *Dr. Wilton Marion Krogman* will headline the conference featuring *Growth and Development of Children and related subjects.*

Our speaker is extremely interesting and presents material that can be put to use in your practice.

Arrangements are being made by Dr. Krogman to present abstracts of his presentation to all conferees as well as a bibliography of suggested reading relative to his presentation. This material will be sent to you when your completed application has been received.

ALL this AND:

1) *Dr. Michael J. Walsh* on "Nutrition in Action".
2) *Dr. Wm. W. Wainwright* on "A survey of Radioactive Isotope research in Dentistry and how it can be applied to practice".
3) *Dr. Robert Ricketts* on "Cephalometric Analyses—How to read them and apply them to your diagnosis".

The conference will open with Dr. Krogman's first presentation after the completion of registration at 2:00 p.m. The session will conclude with luncheon Friday noon.

The conference fee is $85.00 including lodging and meals. This fee may be paid in two installments if desired—$25.00 must be paid with application and the balance of $60.00 by Feb. 15th. Make checks payable to the C.S.D.C. and mail, together with application enclosed, to:

Miss Lorraine Duncan
3780 Wilshire Blvd.
Los Angeles 5, California

Due to the limitation of space reservations are limited. $25.00 of registration fee not refundable.

Our Annual Table Clinic Meeting, held January 16 at the Nikabob, was a huge success. The program, designed to demonstrate practical procedures in dentistry for children, presented the following clinics:

Irving Rubel, D.D.S. *"Prophylactic Orthodontic Appliance."*
Rex R. Waggoner, D.D.S. *"Fractured Anteriors"* (plastic).
Roger Eckblom, D.D.S. *"Fractured Anteriors"* (steel).
Wallace May, D.D.S. *"Fractured Anteriors"* (gold).
John Whitaker, D.D.S. *"Space Opening".*
Mode Perry, D.D.S. *"Photography".*
Bernard Rabinowitch, D.D.S.
Julian Singer, D.D.S. *"Comminuted Fractures and Casts".*
Richard Hallberg, D.D.S. *"The Hemophilia".*
Robert Burnett, D.D.S. *"X-rays for Children".*
Dutch Everett, D.D.S.
Joseph Raskin, D.D.S.
Leon Leonard, D.D.S. *"Observations of Crooked Teeth".*
Ruth Weinstein, D.H. *"Dental Hygiene Program at Sister Kenny Hospital".*

Ohio

A luncheon meeting was held at the Statler Hotel in Cleveland, Ohio, on November 16, 1955, in conjunction with the Ohio State Dental Convention.

Dr. M. S. Goodman presided and introduced Dr. R. L. Holle who reported on the Pediatric Division of Cincinnati's dental health program.

Dr. Edward L. Pettibone provided the highlight of the day with a very inspiring talk on the possibilities of next year's program. His incentive gave us all the desire to increase our efforts toward a better State Unit during the oncoming year.

The following were elected Ohio State Unit officers for 1956:

President, Dr. Finn L'Orange, 12734 Woodland Ave., Cleveland, Ohio

Vice-President, Dr. R. L. Holle, 438 Doctors Bldg., Cincinnati, Ohio

Secretary-Treasurer, Dr. William C. Maddox, 1223½ N. High St. Columbus 1, Ohio

Columbus

The Columbus, Ohio, local section of the Ohio Unit began its 1955–56 program with a dinner meeting at the Ohio Union on Nov. 2, 1955.

Dr. Lyle Pettit gave a brief report of the National A.S.D.C. meeting at San Francisco which he attended in October.

Dr. Charles M. Pfersick, of Washington C.H., Ohio, was the guest speaker for the evening, his subject being "Hypnodontics and its Application to Children's Dentistry." Not only was his demonstration of applied hypnodontics entertaining, but his application of practical child psychology very useful. There were nine volunteers, who if doubtful before, can now vouch for Dr. Pfersick's ability as a hypnodontist.

New Jersey

Dr. Francis Lehr reports the midwinter meeting of the New Jersey Society of Dentistry for Children, held on Wednesday, January 11th, was a complete success, due largely to the efforts of our Chairman, Saul Gale, and the help he received from his committee. The program consisted of an afternoon of table clinics presented by four members of the staff of the Pedodontic Department of New York University Dental School, under the direction of Dr. Hal Addelston. The subjects presented were as follows:

Dr. Julius Ozick: "Treatment of Pulp of Primary Teeth".

Dr. Stanley Hoch: "Treatment of Fractured Anterior Teeth of Children".

Dr. Mark Wallach: "Amalgam Restorations for Primary Teeth".

Following the clinic presentations a cocktail party was held, after which a dinner was tendered the speaker of the evening, our own Dr. Alfred E. Seyler, Editor of the Journal of Dentistry for Children and the Journal of the American College of Dentists. The evening's program was highlighted with the presentation by Dr. Seyler of a paper on "An Analysis of the Child Patient, Parent, and Dentist Relationship".

Preparations are now underway for our annual meeting to be held in conjunction with the annual meeting of the New Jersey State Dental Society. The date has been set for Tuesday, April 24th in the Rose Room of the Hotel Traymore in Atlantic City. A speaker of national repute will present a paper, and we shall have final details on this meeting in the next issue of the Journal.

Our Post-Graduate Studies Committee, headed by Milt Cooper, has completed arrangements for the presentation of a

one-day intensive study course under the sponsorship of our component society. He has been successful in securing as our lecturer Dr. Ralph L. Ireland, of the University of Nebraska, Secretary of the American Board of Pedodontics. The course is scheduled for Friday, March 16th, from 9 a.m. to 5 p.m., and will be conducted at Fairliegh-Dickinson Dental School in Teaneck. A limit of twenty-five may take the course, and details and applications will soon be forthcoming from Milt Cooper. Those of you who took the course last year from Dr. Kenneth Easlick know what an instructive and informative day it will be. The subject will pertain to "Practical and Applied Pedodontics for the General Practitioner".

Committee heads have just been appointed for working out the program and details of the forthcoming national convention of the American Society of Dentistry for Children. As you know, our component will be hosts this year at the Annual Meeting in the fall, when our own Larry Burdge takes over the reins of the presidency. We want to do him proud, so we're getting started now. Watch for further details in subsequent issues of this Journal.

New York

On Sunday November 6, 1955 at its Annual Meeting, the Dental Guidance Council for Cerebral Palsy in New York presented a panel discussion on problems relating to dental treatment for children with cerebral palsy. Dr. Solomon N. Rosenstein, President of the Council, presided and the essayists were: Dr. Joseph H. Kauffmann, Dr. Arnold C. Rosenberg, Dr. Eugene J. Weisman and Dr. Seymour Koster. All are members of the New York State Unit of the A.S.D.C.

The essayists presented the following topics, respectively:

1) Psychological Aspects of Dentistry for Children with Cerebral Palsy;
2) Routine Dental Care for Children with Cerebral Palsy;
3) Diagnosis and Treatment of Periodontal Disturbances in Children with Cerebral Palsy;
4) Diagnosis and Treatment of Disorders of Occlusion in Children with Cerebral Palsy.

The meeting was well attended by members of local and nearby Units of the A.S.D.C. The discussions were very well received and it is expected that the papers will be submitted to our Journal.

Metropolitan Unit

Plans for the coming year of the Metropolitan Unit of the New York State Society of Dentistry for Children have been announced by its President, Dr. Stanley R. Spiro. In implementing its purpose of acquainting the general practitioner with new techniques and developments in the field of pedodontics, the Unit will not only continue its program of study groups, but will add an innovation—field trips. It is expected that members will visit the Guggenheim Dental Clinic and the Pedodontic Clinics at Columbia University and New York University. The meetings which precede the field trips will be devoted to a presentation, by the respective staffs of some of these institutions, of the philosophy, techniques and procedures used in their clinics. Opportunity will be given for general discussion.

Members of the Metropolitan Unit will also continue, as they have done since the inception of the Unit, to participate in health education activities, such as Children's Dental Health Week, the fluoridation campaign, and other helpful

projects. All colleagues in Greater New York are urged to join the Metropolitan Unit, register for its study groups, and become active participants in its program, which is designed to help every dentist with his problems in the practice of pedodontics.

M. Joel Freedman, Secretary
300 West 23rd Street,
New York 11, N. Y.

Oregon

Eugene L. Bunch reports the Oregon Unit of A.S.D.C. held its first Fall meeting September 28th at the Dental School of the University of Oregon. Dr. Robert O'Neil, well known Pedodontist from Vancouver B. C., was the clinician for the afternoon session. His topic, "Indications and Technique for Stainless Steel Crowns" was well received by the members and guests present. The evening dinner meeting was held at Berg's Chalet with Dr. O'Neil speaking on "Diagnosis and Treatment Planning for Children". This meeting was attended by a large number of out of town members and guests.

Other programs for the year include a presentation by a group of Portland orthodontists, a joint meeting with the Portland Academy of Pediatricians, and possibly a joint meeting with Washington State and British Columbia Societies in the Spring at Harrison Hot Spring, B. C.

The Oregon Unit this year is showing tremendous enthusiasm toward encouraging new membership and participation in the various activities throughout the state. Committee members of the various districts are busy contacting dentists interested in dentistry for children.

"Children's Dental Health Week" in February was one of the projects in which the unit took an active part. Chairman for the event was Dr. Robert Gardner, Pedodontist from Oswego. He worked in conjunction with the Portland District Dental Society and the A.D.A. to make the week a success. The group conducted dental examinations, took bite-wing x-rays on children, and presented displays and information on dental health.

Officers for the Oregon Unit are:

President, Dr. Kenneth Jensen, 2300 S. W. Broadway Drive, Portland

President Elect, Dr. Donald Porter, 5712 S. W. Nebraska, Portland

Secretary-Treasurer, Dr. Evelyn Strange, 6404 N. Villard Ave., Portland

Program Chairman, Dr. Theodore Suher, 4640 N. W. Woodside Terrace, Portland

Editor, Dr. Eugene Bunch, 11736 N. E. Eugene St., Portland

Arkansas

We of the Arkansas Unit, wish to pay tribute to our friend and colleague H. Shirley Dwyer, whose sudden and untimely death October 20, 1955, has left a great void within our organization.

Dr. Dwyer was Director of the Division of Dental Hygiene of Arkansas, an active member of our Unit and charter member of the original American Society for the Promotion of Dentistry for Children. His many contributions to public health dentistry and to the field of dental health education marked him as a leader and pioneer in the rise of the dental profession during the period of its most active growth. His remarkable accomplishments in Arkansas during the past two years are a reflection of his genius and superb talent. Courageous in the face of difficult and burdensome tasks, altruistically dedicated, diligent and capable in his application to his many responsibilities, Doctor Dwyer has earned

a grateful and affectionate remembrance of the entire membership of the Arkansas State Unit.

May the light of his life serve to illuminate the dark road ahead as we consecrate ourselves, in memory of his inspiring achievements, to the ideals of his partially fulfilled dream.

H. Shirley Dwyer

Rhode Island

Other Units would do well to observe the activity in the Rhode Island group, which was organized in 1950. Roger Brown has sent us copies of the programs put on recently and it is easy to understand why their attendance is usually around 75, and still going up!

In October a panel discussion on every day office problems pertaining to the child patient was presented. Jim Kershaw, Frank Bliss and Richard Deutch were the speakers.

In November, Jay Rice Moody, D.M.D., head of the dental department, O.P.D. at Newport Hospital spoke on the more effective use of auxiliary personnel in the practice of dentistry for children, presenting a colored movie taken in his own office, to demonstrate his lecture.

Iowa

E. C. Prall of the Iowa unit has reported the following program for the annual meeting:

Place—Garden Room, Kirkwood Hotel, Des Moines, Iowa.

Date—Monday, April 2nd, 1956

Program:

9:30 A.M., Registration

10:00 A.M., Dr. Ralph L. Ireland, of College of Dentistry, Lincoln, Nebraska. Subject: "A Consideration of Cavity Preparation for the Primary Teeth".

12:00 M., Luncheon, Garden Room, Followed by Business Meeting (Luncheon $2.00).

1:30 P.M., Dr. Ireland will discuss Pre-Medication and Co-Medication; also other items such as First Appointment Routine, Roentgenographic Surveys for Children, The Consultation Period with the Parent, and Parent Education.

Pan-American

Sam Harris reports as follows: "The Pan-American Council" of Dentistry for Children is progressing in fine fashion. Colombia, Nicaragua, Cuba, Mexico, the United States and Canada are now officially members. Argentina, Guatemala and El Salvador will be joining as soon as certain technical matters are adjusted.

Those elected to office for the next term are: Carlos Criner, Cuba; President, Benjamin Gomez, Colombia; President-elect, Antonio Fragoso, Mexico; vice-President, Antonio Montero, Cuba; Sec-

retary, Al Anderson, U.S.A.; Treasurer, Samuel Leyte, Argentina; Editor, Samuel D. Harris, U.S.A.; Chairman of Executive Committee.

Dentistry for children appears to be a popular news item in the Pan-American countries, and we hope to be able to report substantial progress during the coming year.

with various phases of pedodontics that made it easier and better for both child and dentist.

In December Charles Sweet, Sr. of Oakland, California gave a most informative and scholarly talk on indications and contraindications for the use of calcium hydroxide and other pulpal medicaments.

Representatives of the North, Central and South Americas in attendance at the Mexican Dental Congress. Sam Harris second at left.

Hawaii

B. A. Sherman reports from Honolulu that Hawaii Unit of the A.S.D.C. has had the pleasure of having two outstanding professors of pedodontics speak before the group. At the October meeting Walter C. McBride of Detroit, Michigan presented a discussion entitled "Something Better for the Kids" which dealt

NOTICE

Deadline dates for material to be published in our Journal in 1956 are as follows: 2nd Q April 1, 3rd Q June 1, 4th Q October 1.

Unit News should be sent to Mel Noonan, 630 N. Woodward, Birmingham, Michigan at least two weeks prior to the above dates.

Conditions Influencing the Incidence of Occlusal and Interstitial Caries in Children

GILBERT J. PARFITT, F.D.S., M.R.C.S., L.R.C.P.*

INTRODUCTION

THE most common sites of dental caries are on the occlusal and interproximal surfaces of the teeth. Causative factors associated with dental caries such as diet, buffer capacity of the saliva and the presence of acid forming oral microorganisms, would be expected to influence the incidence of caries in the two sites proportionately. However, certain observations suggest that caries in the two sites might be under the influence of different factors and further study has confirmed that independent variations do occur.

It is frequently observed that some individuals suffer mainly from occlusal caries while others have a preponderance of interstitial caries. This may be nothing more than the two extremes of an expected chance variation. On the other hand, it may point to an independence of factors.

In some respects the two sites differ fundamentally from each other. On the occlusal surface deep fissures form a site for food stagnation from the time of eruption. Food is constantly being forced into these deep and narrow channels during mastication. Acid fermentation probably proceeds in the deepest parts where the material remains undisturbed because clearance of the fissure contents is never achieved in spite of continual replenishment of food at the entrance. These fissures contain a variety of substances, including protein. This material is soft, infected, permeable, and offers little or no protection from caries.

Interproximal surfaces are smooth, rounded areas, to which liquids, fine particles and semi-solid foods gain ready access. The length of time such material may remain undisturbed depends upon many local factors. Should sufficient space exist between the teeth, this mixture of food and bacteria may be swept away by fibrous food, but when teeth are in contact material lodged interproximally may remain undisturbed for many days.

Nevin (1954) has studied the diffusion of soluble substances both into and out of spaces similar in shape to fissures and interstitial areas. He considers that the factors which promote caries such as the qualities of the food, permeability, adhesiveness, buffer capacity, acidity and sugar-forming potentiality, are considerably modified by the shapes of the teeth and their spacing. He also points out that masticatory function may assist in the inception of caries by permitting entry of sugar into spaces and subsequently blocking the spaces with food mixtures of low permeability. When diffusion is unimpeded by food debris, muscular movements, together with an ample flow of saliva, may assist in the clearance of sugar and acid from the interdental spaces. He suggests that "when evaluating caries control measures, all new caries should be reported in terms of the type of surface involved."

Owing to the morphological differences in the two common sites of caries, the

* Professor of Dentistry, University of Alabama, School of Dentistry.

conditions affecting the incidence of caries in these two sites have been studied. Data were available from surveys on the incidence of dental caries in various groups of children including two longitudinal† surveys in which a total of 10,000 examinations were carried out using a standard technique of examination (Parfitt, 1954). All discrete carious cavities clinically involving the dentin were recorded, more than one such lesion often occurring on the occlusal surface of some of the teeth. Some bitewing x-ray films were also available. By regrouping this material sufficient data were obtained to study the effect of various oral factors on the incidence of caries on specific sites of the teeth.

The Effect of the Proximity of a Tooth on the Caries Experience of a Smooth Surface

Retention of food and a certain amount of dental caries are found on the distal surface of the last tooth in the dental arch. When another tooth erupts distally, this surface becomes the site of interproximal stagnation and dental caries is enormously increased. Although the bulk of food retained may even be diminished, the conditions of stagnation have been altered.

The caries incidence on the distal surface of the second primary molar is a suitable illustration of this effect, for this surface is exposed in the mouth for four years before eruption of the first permanent molar and it remains in contact for a further period of four years. Before eruption of the permanent molar the caries experience is low but on contact with another tooth an immediate increase in caries rate occurs similar to that on its mesial surface which from the time of eruption has been in contact with the distal surface of the first primary molar. This is demonstrated in Figure 1.

† In a pure longitudinal survey, each child is examined at every age. In a mixed longitudinal survey, all children are examined at least twice but some or all fail to appear over the whole age range covered by the survey.

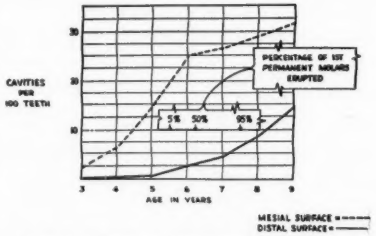

Fig. 1. Caries on distal surface and mesial surface of the upper and lower second primary molars.

The Effect of the Width of the Interdental Space on the Caries Experience of the Two Opposing Surfaces

In 200 unselected cases the width of the interdental spaces was measured with a tapered instrument calibrated for the purpose. Caries was charted in the standard manner.

Caries on the interproximal surfaces was found to be greatest when the teeth were in contact and caries became progressively less with spacing. Even with 0.5 mm. space between the teeth, caries was so much reduced that this measurement was taken as the lower limit to a "space." This criterion was used in the data presented in Table 1. It can be seen that in this particular group of 57 children aged 4 years, caries is ten times more common when the teeth are not spaced. Caries in spaces caused by a missing tooth was not counted. Although these children were unselected, in order to make sure the figures were not biased by the presence

TABLE 1

Interstitial Caries and Spacing of Teeth in 57 Unselected Cases, Age 4+

Specific Tooth* Surfaces	Teeth in Contact		Teeth Spaced ≥0.5 mm.	
	Total number of tooth surfaces	Number of surfaces carious	Total number of tooth surfaces	Number of surfaces carious
a–a	60	21	46	3
b–a	64	15	156	4
c–b	64	3	160	3
d–c	90	11	130	0
e–d	200	23	22	0
a–a	56	4	56	0
b–a	100	8	128	0
c–b	104	8	106	0
d–c	92	10	122	2
e–d	208	30	8	0

* First primary incisor to second primary molar denoted a–e.

Upper teeth underlined.

Lower teeth overlined.

of a number of children with low caries experience and well-spaced teeth, the children were divided into two groups, those with well-spaced teeth and those with crowded teeth, or with teeth in contact. Occlusal caries, which is unaffected by spacing of teeth, was taken as an index of caries experience and was similar in the two groups. It was 1.48 and 1.67 carious or filled teeth per child in the two groups respectively.

The Effect of One Carious Interproximal Surface upon the Caries Experience of an Approximating Surface

Bitewing x-ray films were examined of individuals where both the first and second primary molars were present. The ages of these children ranged from 6–9 years. Older children showed a greater incidence of both surfaces carious as would be expected from an increase of caries with age. Table 2 shows the number of carious and caries-free upper and lower primary molars found, and in brackets are the numbers which would be expected to occur by chance alone.

The appropriate value to calculate and show that the two adjacent surfaces are similarly affected is the χ^2 value. These are highly significant, for both upper and lower teeth show that there is an excess of surfaces both affected (either carious

TABLE 2

Analysis of 178 Upper Pairs and 163 Lower Pairs of Primary Molars Showing the Number of Pairs with Both Teeth Carious, One Tooth Carious or Both Teeth Caries Free

	Upper First Primary Molar			Lower First Primary Molar	
	+	−		+	−
Upper second primary molar			Lower second primary molar		
+	98 (73)	10 (35)	+	95 (83)	2 (14)
−	23 (48)	47 (22)	−	45 (57)	21 (9)

\+ = carious.

− = caries-free.

Figures in parentheses are those expected by chance.

or caries free) and a corresponding deficit of cases in which only one of the two surfaces is carious (χ^2 = 65.5 upper, 28.7 lower for one degree of freedom. P <1%). This strongly suggests that the two proximal surfaces are similarly affected either by similar conditions in the interproximal space or because a surface becoming carious causes the other to become carious also.

The Difference in Caries Experience on the Distal Surface of the First Primary Molar and the Mesial Surface of the Second Primary Molar

It was found that more caries occurs on the distal surface of the first primary molar than on the mesial surface of the second primary molar. For every 100 second molars lost by caries, 140 first molars were lost, and for every 100 cavities in the mesial surface of the second molar, 131 occurred on the distal surface of the first molar.

One possible explanation of the greater number of cavities on the distal surface of the first primary molar is that each surface follows a definite pattern of caries experience. Such pattern might comprise an initial period before the appearance of a cavity followed by a rapid succession of cavities increasing in frequency to a maximum, finally assuming a more constant rate. As the first primary molar erupts 12 to 18 months earlier than the second, the patterns of caries experience would be separated by an interval of approximately 18 months.

Figure 2 shows the yearly caries incidence per 100 remaining teeth of these two surfaces in the upper jaw from the age of 2 to 11 years. It demonstrates that the patterns made by the caries experience, although remarkably similar in shape and extent, are not separated by an interval of time but are synchronous, every change in rate in the two curves occurring at the same age.

Another possible explanation for the greater number of cavities present in the distal surface of the first primary molar might be that an accumulation of cavities on this surface occurs before eruption of the second molar. Referring again to Fig. 2, it can be seen that a lead of 4 cavities per 100 teeth at the age of 4 years on the distal surface of the first molar is maintained throughout the

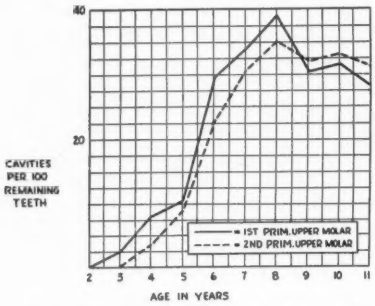

Fig. 2. Caries on the distal surface of the first primary molars and the mesial surfaces of the second primary molars from the age of 2 to 11 years.

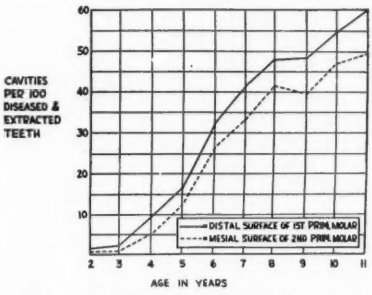

Fig. 3. Caries on the distal surface of the first primary molars and mesial surface of the second primary molars in diseased and extracted teeth.

changes in caries rate up to the age of 9 years. From 9 years onwards, owing to a greater loss of first primary molars through caries, a larger number of cavities appears on the mesial surface of the remaining second primary molars. In the lower jaw, similar synchronous patterns were found but with a lead of 10 cavities per 100 teeth on the distal surface of the first primary molar.

An accumulation of cavities before eruption of the second molar is therefore the most likely explanation for the greater number of cavities present on the distal surface of the first primary molar. However, there is a third possibility, this being that the susceptibility of the two surfaces to caries may differ.

It should be pointed out that these three possibilities in no way preclude one another.

Figure 3 shows the calculated caries experience on the mesial surface of the second primary molar and the distal surface of the first primary molar of both the diseased and missing teeth. The number of cavities present on the extracted teeth was calculated from the findings of one of the longitudinal surveys. In the upper jaw, 115 second primary molars lost through caries were found to contain 70 mesial surface cavities, and in the lower jaw 113 teeth contained 77 cavities. In the upper jaw, 161 first primary molars lost through caries had 111 distal surface cavities and in the lower jaw 156 teeth had 129 cavities. Fifty per cent of the first primary molars and thirty per cent of the second molars had been lost by the age of 9 years. From the age of 9, therefore, less than half of the cavities were in teeth still present in the mouth, more than half being calculated from the findings of the previous data.

The caries incidence of the two surfaces in Figure 3 diverge slightly but as the figures above the age of 7 or 8 have been largely calculated and were not directly measured, tentative deductions only can be made. Such divergence might be due to a difference in caries incidence rate, demonstrating a difference in caries susceptibility between the two surfaces.

Such difference in susceptibility is also suggested by the findings set out in Table 2 and further strengthened by x-ray findings. Between the age of 6 and 9 years, 22% of the cavities in the distal surface of the first primary molar were more extensive than the opposing cavities in the second molar and in only 2% was the position reversed. In the lower jaw 28% of the cavities in the first molar were more advanced and in only 6% were they more advanced in the mesial surface of the second molar.

A greater susceptibility to caries might be due to a difference in shape, structure or formation or could be the result of the extra exposure in the mouth of the distal surface of the first primary molar. This in some way renders the surface more prone to caries on becoming the site of interproximal stagnation. A difference in the susceptibility of these surfaces to caries, however, would be expected to lead to a greater difference in the caries incidence rates than is shown in figure 3. But the incidence rates might tend to be kept parallel by the effect already shown that one carious surface causes the other to become carious also.

The finding that cavities in the first molar are more advanced than those in the second at the ages of 6–9 years suggests that in addition to the lead of a small number of cavities on the distal surface of the first primary molar on account of its earlier exposure in the mouth, some structural difference is also present.

Evidence of Independence of Factors Influencing Occlusal and Interstitial Caries

The independent presence of occlusal and interstitial cavities is demonstrated by an analysis of the caries experience in these two sites in the primary molars of 454 children aged 6. These children were grouped according to the number of occlusal and interstitial cavities present in the primary molars. The highest number of occlusal cavities recorded was 19 out of a possible 22 discrete areas and 10 interstitial cavities out of 12 available surfaces.

In Figure 4 the average number of interstitial cavities for a specified number of occlusal cavities up to 14 is given; only 9 individuals had more than this number. It is seen that the average number of interstitial cavities for those with no occlusal cavities is little less than those with 12–14 cavities. In fact, the average number of interstitial cavities rose by less than one cavity over the whole range, which denotes considerable independence of factors. This is also confirmed by the calculated correlation coefficient which is $r = +0.33$. A similar analysis was made of the caries experience of 257 eight year old children. Although there was a rise in the general level of interstitial caries by approximately 0.5 of a cavity over the whole range, the same low correlation between the two was apparent.

In Figure 5, the presence of independent factors for occlusal and interstitilo caries of the buccal segments is alsa demonstrated by the yearly percentage of caries in the remaining upper teeth of children in the vicinity of London from the age of 2 to 12 years. This shows that the interstitial caries of the buccal segment follows a different pattern from either the occlusal caries or the interstitial caries of the incisal segment. The ratio of interstitial caries of the incisal segment to occlusal caries in the buccal segment remains approximately the same throughout this age range. Because in this particular incidence the same pattern is followed, it cannot be inferred that in other circumstances it will always do so. The calculated correlation coefficient was in fact only $r = +0.39$.

The ratio of occlusal caries to interstitial caries of the buccal segment varies with age, but should any factor affect either occlusal or interstitial caries unequally, the ratio at any particular age will alter.

Longitudinal studies also show the pattern of new carious cavities in these two sites to be similar to that of the static survey.

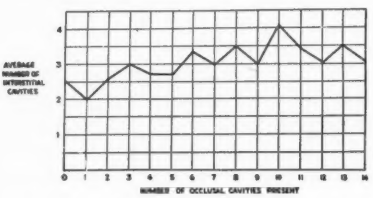

Fig. 4. Average number of interstitial cavities in first and second primary molars in 454 children aged 6 grouped according to the number of occlusal cavities present.

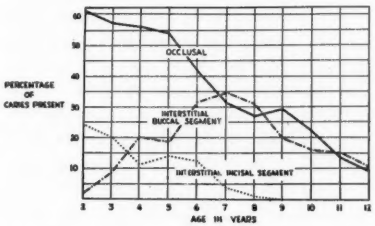
PERCENTAGE OF CARIES PRESENT
OCCLUSAL
INTERSTITIAL BUCCAL SEGMENT
INTERSTITIAL INCISAL SEGMENT
2 3 4 5 6 7 8 9 10 11 12
AGE IN YEARS

Fig. 5. Percentage distribution of occlusal and interstitial caries in the primary dentition from the age of 2 to 12 years (3,000 cases).

Factors Which Affect the General Level of Caries without Altering the Ratio of Occlusal to Interstitial Caries

Many factors which affect the general level of caries appear to affect occlusal and interstitial caries equally.

In any group of individuals some have considerably more caries than average and some have less. Every factor capable of direct or indirect effect on the level of caries is no doubt involved but in a particular group of individuals, which factors are operative and what effect a particular factor has in causing a high rate of caries is impossible to determine. The high caries experience, however, is in itself evidence of the presence of such factors. In the data reported in Table 3, three hundred and seventy-seven individuals aged 6, all showing some degree of dental caries, were divided into three groups according to the number of teeth involved: those with 1–4 carious teeth; those with 5–7 carious teeth; and those with more than 7 carious teeth. In spite of there being a great difference in caries level, and ten times the number of teeth missing in the higher caries group, the ratio of occlusal to interstitial caries is very similar in the three groups, i.e., between 100:56 and 100:66.

In another group of 47 children of the same age living in an institution, with an average of only 2.7 carious teeth per child, the ratio of occlusal to interstitial caries was similar, i.e., 100:60. The factors peculiar to institutional life would seem therefore to be equally effective in reducing the level of occlusal and interstitial caries.

TABLE 3

Occlusal and Interstitial Caries in the Primary Molars of 377 Children Aged 6 Divided into Three Levels of Caries

Total No. of Carious and Extracted Teeth	No. of Children	No. of Extracted Teeth per 100 Children	No. of Occlusal Cavities per 100 Primary Molars	No. of Interstitial Cavities per 100 Primary Molars	Ratio of Occlusal/Interstitial Caries
1–4	139	20	16	9	100/56
5–7	99	88	63	39	100/62
8+	139	264	99	65	100/66

To assess the effect of the single factor of water-borne fluorine intake on dental caries experience, children living in high and low fluorine areas were examined. The difference in caries levels of the children aged 4 was 105 cavities per 100 children but the ratio of occlusal to interstitial caries was unaltered. In the high fluorine area it was 100:42.5 and in the low fluorine area it was 100:42.2. The presence of fluorine in the drinking water, therefore, appears to affect caries in both sites equally in these groups.

In order to balance as far as possible factors other than the fluorine content of the drinking water, three pairs of towns were selected in north, east and south England for this survey, one of the pairs in each district having a high and the other a low content of fluorine in the drinking water. The communities resembled each other in other respects as closely as possible. Although the ratio of occlusal to interstitial caries in the children's teeth from the combined high fluorine areas and combined low fluorine areas were so similar, the ratio was 100:35 in the south of England and 100:59 in the north, a difference which is as yet unexplained.

Factors Which Alter Both the General Level of Caries and the Ratio of Occlusal to Interstitial Caries

Differences in the diet of various national groups are considered to be

TABLE 4

Levels of Occlusal and Interstitial Caries in the Temporary Teeth in Different National Groups

Group	Age	D.E.F. Teeth per 100 Children	Occlusal Cavities per 100 Remaining Primary Molars	Interstitial Caries Buccal Segment per 100 Remaining Primary Molars	Interstitial Caries Incisal Segment per 100 Remaining Upper Incisors	No. of Extracted Primary Molars per 100 Children	No. of Extracted Upper Incisors per 100 Children
English	6	723	46	45	13	172	100
Australian	6	826	55	51	25	210	80
New Zealand	6	867	102	34	27	50	80
Penang	6	1359	51	64	82	213	130
Singapore	6	1158	58	57	85	256	220
English	8	814	51	55	—	283	—
Australian	8	986	55	65	—	264	—
New Zealand	8	1156	103	68	—	60	—
Penang	8	1030	53	52	—	350	—
Singapore	8	1345	90	53	—	570	—
Special group	5–10	44	1.6	4.5	—	—	—

mainly responsible for variations in the level of dental caries. Sample groups of children, in all 282 aged 6 and 342 aged 8, were examined in several different countries within a period of weeks.

Children of British stock were examined in London, England; Sydney, Australia; and Wellington, New Zealand; and of other stock, Malays in Penang and Chinese in Singapore. The findings are set out in Table 4. Dental caries is divided according to its site into occlusal, interstitial in the buccal segment (distal to the cusp of the primary canine) and interstitial in the upper incisor segment (mesial to the cusp of the primary canine).

The ratio of occlusal to interstitial caries in the English children is higher than was found previously, the 6+ age group having the characteristics of the 7+ or 8+ groups in previous surveys. The Australian childrer have a slightly higher level of caries than the English children and this is more pronounced in the incisal segment. In the New Zealand children, the high level of occlusal caries stands out from the other groups and although the interstitial caries in the buccal segment is low at the age of 6, it is higher than in the other groups at the age of 8. Caries in the incisal region is similar to that in the Australian groups. The intensive treatment which the New Zealand children receive, which is reflected in the small number of missing teeth, may "artificially" increase the number of occlusal cavities and surfaces involved, for although obvious prophylactic fillings were not counted as caries, a few fillings may have been extended on to the occlusal surface and extra occlusal cavities scored. In spite of this bias, occlusal caries seems to be particularly high in the New Zealand groups.

The Malay children have a high level of dental caries and interstitial caries is much higher, particularly in the incisal segment, but occlusal caries is on a level with the Australian groups. These high levels of interstitial caries are shown by the Chinese of Singapore who at the age of 8 also have a very high rate of oc-

clusal caries and moreover, the highest number of missing teeth of any group.

An accurate dietary survey could not be carried out in these countries but the great difference in diets in these groups is suggested as the cause of both the level of caries and the alteration in the ratio of occlusal to interstitial caries.

Tooth morphology or structure might be a factor in causing the ratio to vary in different localities, for by absence of occlusal fissures or by flattened interproximal surfaces in the Chinese and Malay groups, the ratio of occlusal to interstitial caries might differ. No difference in tooth morphology between the British and other groups could be detected at examination and moreover, occlusal caries was as high in the Malay and Chinese groups as in the British.

Finally, a special group of 66 Australian children (Table 4) was examined in whom caries had been virtually eliminated by almost complete absence of sugar and finely ground flour from the diet. The children were given a diet composed mainly of wholemeal bread, wholemeal biscuit, wholemeal porridge, wheat germ, fruits (fresh and dried), vegetables (cooked and raw) and a small amount of meat, butter, cheese, eggs, milk, fruit juices, and nuts. It can be seen that in this group occlusal caries has been even more reduced than interstitial caries.

Diet, therefore, appears to be capable of altering not only the level of dental caries but also the ratio of occlusal to interstitial caries.

Full dietary surveys might confirm the impression that the highest incidence of interstitial caries is found in areas where the diet is preponderantly soft and semi-liquid and the highest occlusal caries in areas where manufactured and sweetened foods made from finely ground flour are in excess. The lowest incidence of occlusal and interstitial caries was in the group whose diet consisted of coarse and fibrous food, free from finely ground refined flour and sugar.

Finally, it should be stated that although the numbers of children examined in these sample groups were necessarily small, the findings agree closely with large surveys being carried out in each of the countries visited.

Summary

(1) The incidence of dental caries appears to be under the influence of independent factors on (a) the occlusal surfaces of the teeth, (b) the interstitial surfaces of teeth in the buccal segment, (c) the interstitial surfaces of the upper incisors.

(2) Caries in each site is affected to a similar degree by susceptibility of the individual to caries, institutional life and different levels of fluorine in the drinking water.

(3) Caries in each site appears to be affected unequally by different diets.

(4) The proximity of another tooth and the width of the interdental space considerably affect the incidence of caries on the interstitial surfaces of the teeth.

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An Evaluation of Vital Pulpotomy Technique*

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EVERY dentist who sees children in his practice is concerned with pulp conservation. There is a need for more knowledge concerning the usefulness of various methods of pulp therapy. The following approaches to treatment of the exposed pulp in the child have been advocated:

1. Capping
2. Partial pulpotomy or pulp curettage.
3. Vital pulpotomy with calcium hydroxide.
4. So-called de-vital or therapeutic pulpotomy using formalin-type drugs.
5. Endodontics.
6. Extraction.

Since 1938, the technique of vital pulpotomy using calcium hydroxide has been widely used on primary and young permanent teeth. This technique, using a mixture of salts including calcium hydroxide, was first described by Hermann[1] in the German literature; and later in this country, Teuscher and Zander[2] reported on the use of calcium hydroxide only. The technique, as advocated by Teuscher and Zander, will be briefly reviewed to insure that we are on common ground.

The tooth with the probable exposure is suitably anesthetized. Pressure anesthesia is contraindicated. The rubber dam is applied and the area cleansed with an appropriate antiseptic agent such as zephiran chloride. The superficial caries and debris are next removed, and the occlusal portion of the tooth is opened up wide and into the dentin for easy access. With a sterile fissure bur, the roof of the pulp chamber is next removed and the bulbous portion of the pulp amputated. Sharp spoons or large round burs have been recommended for this part of the operation. When the tissue has been cleanly separated down into the orifices of the root canals, the chamber is cleansed with a suitable agent such as sterile water or procaine from the dental syringe. Next, a creamy paste of calcium hydroxide and water is placed over the amputated stumps, followed by a layer of paraffin, then a cement base, and finally an amalgam restoration.

Healing is described[3] as beginning with the formation of an amorphous calcified layer where the pulp tissue was in contact with the calcium hydroxide followed by formation of true dentin in a regular pattern. The pulp usually shows an inflammatory reaction at first, but this tends to disappear.

Since 1938, when this technique was first described, a large percentage of practitioners have adopted it for routine clinical use on exposed pulps in children. Actually, when Teuscher and Zander first reported on this method, they stated "A great amount of work is still necessary before a pulpotomy can be recommended as a practical clinical procedure".[2] Certainly it is time now to ask ourselves some questions:

1. What degree of clinical success can

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we expect from this method of pulp therapy?

2. What have we learned concerning indications and contraindications for vital pulpotomy?
3. What variations from the original technique are worthy of our consideration?

Published reports on the degree of success of vital pulpotomy as used clinically show wide variation. This is to be expected since no two operators will work the same way, differences in interpretation of what constitutes an operable tooth may occur, and differences in opinion as to criteria of success and failure may exist. In addition, studies vary as to the number of cases, the length of time observed, the age of the patients involved, and the proportion of primary to young permanent teeth.

Zander[3] made only one brief reference to clinical success in a report published in 1939. He stated that in 120 cases including primary and young permanent teeth, approximately 70 per cent were satisfactory. Brown[4] reviewed records of 92 primary and young permanent teeth observed from 4 to 47 months and reported 90.2 per cent success. Via[5] repeated a similar study limited to mandibular primary molars. Of 103 cases observed for an average of 24.9 months, 31 per cent were successful according to the criteria of the study.

It is obvious that more studies are needed on clinical success and failure of vital pulpotomy if we are to accurately appraise its usefulness. Only by getting more facts can we determine the direction in which future pulp therapy research should be aimed.

Recently we completed a progress study on 283 vital pulpotomies using calcium hydroxide which were performed by students at the University of Washington School of Dentistry. Selection of cases was based on a normal appearance of the lamina dura and surrounding bone in preoperative roentgenograms and an absence of history of spontaneous pain. No attempt was made to evaluate the

TABLE I

Distribution of 251 Cases—Vital Pulpotomy Using Calcium Hydroxide

Tooth	Number Successful	Number Failures
Primary Dentition		
Maxillary right second primary molar	8	4
Maxillary right first primary molar	14	12
Maxillary left first primary molar	12	13
Maxillary left second primary molar	13	7
Mandibular left second primary molar	14	23
Mandibular left first primary molar	7	18
Mandibular right first primary molar	20	20
Mandibular right second primary molar	13	25
Maxillary left primary cuspid	0	0
Maxillary right primary cuspid	1	0
Mandibular right primary cuspid	1	1
Maxillary left primary central incisor	1	0
Total	104	123
Permanent Dentition		
Maxillary right first permanent molar	6	0
Maxillary left first permanent molar	3	0
Mandibular left first permanent molar	6	0
Mandibular right first permanent molar	5	3
Maxillary right permanent central incisor	0	1
Total	20	4

character of hemorrhage, per se, but any obviously necrotic pulp was rejected. Very small carious exposures, 1 mm.. or less, in which clinically sound dentin surrounded the area of hemorrhage were not treated by the vital pulpotomy technique but by the partial pulpotomy procedure as advocated by Chatterton.[6] Fifteen cases have been so treated up to this date, but are not included in the present report. Surgical exposures were also not subjected to the vital pulpotomy but were treated by calcium hydroxide capping. (Seventeen such cases are under observation but are not included in this report.)

The cases discussed in this report were treated under the rubber dam; and sterile instruments, cotton, burs, etc., were furnished in kit form at the time of the operation. The technique of Teuscher and Zander[2] was followed except that the calcium hydroxide was applied in dry form where convenient such as in maxillary teeth, and the intermediary base of paraffin was omitted. Cases were called for clinical and roentgenographic checkup after a minimum of six months, the average being approximately nine months, with a few cases able to be followed almost five years. Of the 283 cases, 32 failed to return for checkup. Of the 251 teeth on which we obtained records, 124 or 51 per cent were failures and required extraction. One hundred twenty-four or 49% were adjudged successful by clinical and radiographic evidence at the time of examination. Our criterion of success was a tooth firm in its socket with healthy surrounding tissues, free of soreness to percussion and not sensitive or painful. The roentgenogram should show a normal lamina dura, normal alveolar bone, and absence of progressive internal resorption. We did not consider the presence of a visible dentin bridge as essential to success, since some cases have been eminently healthy and functional for a period of years without apparent root orifice calcification.

Of our 251 cases, only 24 were performed on permanent teeth. Twenty of these were successful at the time of checkup and four had failed. Overall success in the 227 teeth of the primary dentition was 46 per cent. Eighty-six of the failures occurred in the mandibular primary molars, amounting to 61 per cent of these teeth treated. In the upper arch, the percentage of failures in primary molars was 43 per cent. The higher mortality in mandibular teeth may be due to the fact that caries attacks the lower arch earlier and, therefore, these pulps are more likely to be in advanced stage of degeneration at the time of operation. It is also generally agreed that a diagnosis of tissue breakdown can be more easily predicted in the roentgenograms of lower molars. In this study, the percentage of success in lower primary molars was 39 per cent.

Via[5] recently reported a figure of 31 per cent success in a study limited to pulpotomy in mandibular primary molars only. However, in his criteria for success, he included the presence of a dentin bridge, a standard which we did not require in our study. It would appear that regardless of whether or not visible calcification is used as a criterion of success, the mortality of primary teeth treated with pulpotomy using calcium hydroxide is higher in the mandibular arch than in the maxillary.

Indications for Vital Pulpotomy

It has been pointed out that reports of success with vital pulpotomy range from 31 to 90 per cent. If the operator knew the extent of degeneration and inflam-

mation in a given tooth, he could predict the possibility of successful healing. Certain diagnostic signposts should be considered in each case before operating.

1. *History of pain.* Early inflammatory changes in the pulp result in symptoms such as temporary sensitivity to thermal changes, or sensitivity when eating.[7] Such a pulp has the potential for healing and recovery if the source of infection is removed. On the other hand, spontaneous pain, such as at night, or prolonged pain after thermal stimulus, usually indicates a pulp which has undergone marked and probably irreversible degenerative changes.[8] Such a tooth is not a good risk for vital pulp therapy.
2. *Character of hemorrhage.* This point is widely discussed in the literature on pulp therapy but empiric observations rather than scientific findings seem to dominate the thinking. Obviously a purulent or necrosed pulp can be differentiated from a vital one. Different degrees of color and abundance of hemorrhage are ascribed to different stages of degeneration. It is interesting that very little hemorrhage is encountered in performing pulp amputations on healthy teeth for research purposes.
3. *Pre-operative roentgenograms.* Normal appearance of lamina dura, and surrounding bone, are prerequisites to vital pulpotomy. MacDonald[9] has pointed out that calcified bodies in the pulp chamber near the area of exposure are associated with advanced pulpal degeneration and contraindicate vital pulpotomy. This gives the operator an additional diagnostic sign which, according to our findings, will be observed in about 5 percent of cases considered for pulp therapy.

Discussion of Variations in Vital Pulpotomy Technique

Although originally suggested as an operation to be completed in one sitting, vital pulpotomy has been modified by some to require as many as three separate appointments.[10] This necessitates an increase in chair time for the dentist which does not seem desirable unless increased success can be substantiated by controlled studies. Use of calcium hydroxide in dry form in a medicine dropper or with an atomizer has been suggested. Originally the material was mixed with water to form a paste. Ease of manipulation seems to be the controlling factor, with no evidence to show any particular form of the drug superior. A commercial product, composed of calcium hydroxide and methyl cellulose, is available for those who desire it; and there seems to be good evidence that this form of the drug is effective in stimulating dentin formation.[11]

The use of hemostatic agents to control hemorrhage of the amputated pulp has been advocated by some clinicians. Calcium hydroxide itself seems to favor clotting. Thrombin, powdered, may be employed successfully. The use of highly concentrated adrenalin solutions in direct contact with the pulp may be of an injurious nature due to their severe vasoconstricting effects, and such agents probably should not be employed.

The use of an intermediary base between the layer of calcium hydroxide and the zinc oxyphosphate cement was recommended in the original work on vital pulpotomy. The purpose of paraffin or zinc oxide and eugenol over the calcium hydroxide was to prevent neutralization of the latter by the acidic cement. However, the only free acid available in the zinc oxyphosphate cement is that on the surface prior to initial setting. Since the amount of calcium hydroxide present is greatly in excess of the transient free acid available from the cement, it seems unnecessary to place a paraffin or zinc oxide intermediary base.

Conclusions

1. A study of 283 cases of vital pulpotomy using calcium hydroxide has been reported with a success of 49 per cent according to clinical and roentgenographic standards.

2 The percentage of failure in primary molars was greater in the mandibular arch than the maxillary.

3. Further clinical studies are needed to enlarge our understanding of the clinical effectiveness of vital pulp therapy.

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NOTICE

Deadline dates for material to be published in our Journal in 1956 are as follows: 2nd Q April 1, 3rd Q June 1, 4th Q October 1.

Unit News should be sent to Mel Noonan, 630 N. Woodward, Birmingham, Michigan at least two weeks prior to the above dates.

A Devitalizing Technic for Pulpotomy in Primary Molars*

MAX NACHT, D.D.S.

THE object of this report is to present an evaluation of the data gathered from the office files of the members of the Vancouver Pedodontic Study Club on 467 primary teeth using formaldehyde paste.† The paste used was made from a liquid containing phenol, formalin, creosote, thymol and a powder containing barium sulphate, iodine, paraformaldehyde mixed immediately prior to its insertion. These cases were all done on regular office patients within an appointment time of not more than 45 minutes. The only contraindication for treatment by this method was the absence of tooth vitality as determined by lack of hemorrhage at the site of amputation of the pulp. Cases were judged as to success or failure from radiographic evidence only. Since these cases were done on office patients the opportunity to obtain a follow-up series of radiographs was probably better than if this study had been done in an institution.

HISTORY

The motivating factor in this study was the high percentage of failures of the pulpotomy technique using calcium hydroxide in the offices of our study club members. We were faced with the problem of trying to save primary teeth with a poor prognosis if we were to continue using calcium hydroxide. Unfortunately the majority of the primary teeth in need of pulp therapy are in this category. This left extraction as the only other alternative. Time and economics are of vital importance in a pedodontic practice and any treatment must of necessity, be within the economic limits of our patients.

For us this factor seemed to eliminate all of the recommended treatments involving pulpectomy or other multiple appointment procedures. We were in need of a one appointment treatment which could be used on pulps in all stages of degeneration except death.

A review of the literature revealed some interesting work done by several men with mummifying pastes. In 1929[1] Dr. Hess, of the University of Zurich, reported negative results in a bacterial analysis of 62 pulps mummified with formaldehyde paste.[2] Dr. H. R. Foster of Oakland in 1936 describes a successful treatment using formocresol and paste. Again in 1939,[3] Dr. K. A. Easlick used the same treatment substituting paraformaldehyde. In the Handbook of Dental Practice—1948,[4] Dr. Charles Sweet describes a treatment using zinc oxide, cresolated formaldehyde and eugenol.

Since the principle of mummification had been used by so many of these eminent men at various times, it was decided that this might be the answer to our problem. The technique adopted was uniform in all offices. As previously stated, the only criteria were that the teeth must be vital at the time of operation and be radiographically negative. History of pro-

* Presented at the Annual Meeting of A. S. D. C., held at San Francisco, October 1955.

† Oxpara powder and liquid (Ransom and Randolph).

longed pain was no longer a contra-indication, as it was with calcium hydroxide.

Technique

1. Anesthesia and rubber dam application.
2. Routine preparation of the tooth for reception of the permanent filling material.
3. Complete removal of the roof over the pulp chamber.
4. Removal of the bulbous portion of the pulp.
5. Control of hemorrhage.
6. An adequate quantity of thick mummifying paste applied to the pulp stumps with slight pressure. The paste was mixed to a heavy consistency immediately prior to insertion and after insertion pressed firmly down with a damp cotton pellet.
7. Placing of cement over the paste. This provides a firm base for the permanent filling material.
8. Placing of the permanent filling material.

The entire procedure should not take over 45 minutes under normal conditions. The patients were asked to return for follow-up radiographs every 6 months. We were able to observe some 467 teeth treated in this manner for periods of up to 5 years.

Results

During the entire course of the study, repeated clinical examinations showed no evidence of any degeneration except for some 30 cases which developed acute symptoms and had to be extracted. The radiographic evidence revealed no significant changes for the first 2 years. Then the picture began to take on a new look in a high percentage of the cases. There seemed to be a progressive loss of bone in the bifurcation. During the entire period of resorption, radiographic changes were quite obvious but no clinical changes were evident. The end result was an early loss of the primary molar and the corresponding early eruption of the succeeding permanent tooth.

A study of the data obtained from the various offices revealed a uniform pattern. At no time was there any discomfort to the patient. The tooth remained functional throughout its retention. As mentioned above there was an early loss of the primary tooth and an early eruption of the permanent tooth. This early eruption seemed to be the result of the gross loss of covering bone. Interestingly enough the permanent tooth erupted so quickly that there was little opportunity for loss of space.

Conclusions

It would appear that although the non-vital pulpotomy did not result in acute periapical disturbances or fistulation as was the case in so many of the teeth treated with calcium hydroxide, major changes in the bifurcation became evident after about 2 years. It should be noted, however, that the treatment did make it possible to carry many teeth that were otherwise doomed to extraction, over certain critical periods in the development of the child, without any apparent ill effects.

Despite the increased rate of resorption of the primary molar, we are still using the treatment for that reason. It was possible by this method to save for our patients 437 valuable teeth at a reasonable cost.

Summary

Four hundred sixty-seven cases were treated with formaldehyde paste. Thirty teeth were lost due to acute symptoms.

An analysis of the radiographs of the retained teeth indicated that the teeth were maintained in good condition for about 2 years. After this period the technique apparently hastened the resorption of the treated tooth and the eruption of the permanent tooth. A search of the literature failed to disclose any reports of follow-up studies on non-vital pulpotomies and therefore it was felt that the data gathered may add some information to the problem of pulp therapy in primary molars.

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Notice

The following men have satisfied the requirements of the American Board of Pedodontics and have been certified as diplomates of the Board:

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Clinical Evaluation of Pulpotomy in Young Adults*

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INTRODUCTION

CARIOUS exposure of the pulp accounts for the vast majority of tooth loss incurred during adolescence and young adulthood. Total pulpectomy and root canal therapy have prevented the loss of thousands of such teeth. However, such treatment requires careful preparation and considerable time with the result that many practitioners and patients prefer the extraction of such teeth with prosthetic replacement later. If a simpler method of treating pulpal exposures could be evolved, many thousands of additional teeth could be preserved. Such a method is offered in the technique of vital (partial) pulpotomy whereby only that portion of the pulp adjacent to the carious exposure presumed to be infected with organisms and undergoing degenerative changes, is removed. In long standing exposures, the entire bulbous portion of the pulp is removed, to the entrance to the root canal (complete pulpotomy). If the pulp is necrotic, a total pulpectomy is the method of choice.

It has been clearly established that a pulp exposed by caries or by accident during operative procedures does not inevitably die. The idea that the pulp must die once it is injured was based on the premise that since the pulp is housed within unyielding calcified walls of dentin and fed through minute foramina at the apex, it was doomed to self-strangulation if inflammation and engorgement and/or infection occurred. The remarkable defensive and reparative powers of connective tissue in general were forgotten. Since the pulp is composed of young connective tissue it is not surprising that many investigators[1-16] have demonstrated the fact that the pulp can and does repair itself following removal of the infected dentin (pulp capping) or the infected portion of the pulp (pulpotomy).

A variety of therapeutic agents has been suggested to cover the amputated portion of the pulp to preserve the vitality of the remainder of the pulp tissue, and to promote healing of the stump by a calcified bridge covering the exposed area.[1-16] At the present time, the evidence favors the use of calcium hydroxide, in different forms, as the dressing of choice. However, the comparative effects of other calcium salts have not been studied nor have the antibiotics been given a fair trial in this procedure.

The purpose of this study was to determine by clinical means, the relative

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The opinions or assertions contained herein are those of the authors and are not to be construed as official or reflecting the views of the Department of the Navy, or the Naval Service at large.

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effectiveness of different calcium salts and antibiotics when used to cover the amputated portion of the pulp after partial or complete pulpotomy in the teeth of young adult males.

Method

The procedure of pulpotomy was standardized for the purpose of this study in order to keep constant, as much as possible, all variables which might influence the results. The only variable was the medicament used to cover the amputated pulpal area.

1. The pulps were first sedated with a temporary dressing of zinc oxide and eugenol for 1 to 7 days prior to operation.

2. A complete history was recorded. This included a history of pain, character of lesion in the tooth plus caries susceptibility.

3. Pre-operative roentgenograms were obtained.

4. A local anesthetic agent was injected (procaine HCl 2% with epinephrine 1:50,000).

5. A rubber dam was applied, and the area cleaned and dried. Tincture of iodine was painted over the tooth and rubber dam.

6. The cavity was then opened cautiously. The appearance of the lesion and the character of decay were recorded. The location of exposure was determined.

7. All *peripheral* decay was completely removed and cavity outline and retention form completed. The area immediately surrounding the exposure was left untouched.

8. The cavity was routinely swabbed gently and lightly with a small cotton pellet saturated with 95% phenol. No phenol was used thereafter.

9. All instruments used thereafter were surgically clean (autoclaved).

10. The carious dentin immediately surrounding the exposure was removed with a large sterile round bur (#6 and #8).

11. As soon as this was accomplished, a new sterile bur was used to amputate the degenerated portion of the pulp immediately under the exposure (partial pulpotomy).

12. If bleeding did not occur at this level, amputation was performed at a lower level, until vital tissue was encountered which bled readily after amputation. In many instances, the entire bulbous portion of the pulp chamber had to be removed before vital tissue could be found at the entrance to the root canal (complete pulpotomy). In a few instances, vital tissue which bled readily was not encountered until the root canals were partially invaded (partial pulpectomy). If vital tissue was not encountered when more than half the root canal had been explored, the case was discarded.

In all cases, the level of amputation was determined by the level at which vital tissue was encountered which bled freely after amputation.

13. The exact location and size of the amputation was recorded.

14. The character of the bleeding was recorded (type and amount).

15. The amputated stump was permitted to bleed freely. No attempt was made to control or to stop the bleeding. This served to wash out dentin débris and bacteria and to relieve any pulp congestion. Excess blood was removed with large sterile cotton pellets.

16. A *thin* clot was allowed to form over the amputated pulp stump. Warm air was gently blown over the blood to hasten clotting. Sufficient time (5 to 15 minutes) was allowed for the formation of a firm clot. The size and character of the clot, the degree of serous exudation

as well as the time required to clot were recorded.

17. The medicament was then placed gently over this clot. The powders were gently blown onto the clot, allowed to remain for ½ to 1 minute to permit adherence to the clot and solution in the serous exudate. The excess was then blown off with a chip blower and a fresh layer of powder was placed over the clot. The pastes were gently placed over the clot in the same manner.

18. In many instances the clot was disturbed during the placement of the medicament or actually dissolved by the powder. Oozing around the pastes was common. These details were noted and recorded. In such cases, sufficient time was permitted for the clot to re-form and the exudation to stop before proceeding.

19. The medicament was covered with a creamy mix of zinc oxide and eugenol to which 2 or 5% zinc acetate had been added to hasten the set (approximately 3 minutes). This provided an excellent seal against further oozing. The fast-setting zinc-oxide-eugenol cement was then covered with a thin mix of zinc phosphate cement.

All medicaments were applied via a syringe and needle or by means of "jiffy" tube made from scotch tape rolled into a small cone, to avoid pressure from the use of hand instruments.

20. The teeth were extracted after periods ranging from 4 days to 9 months. The average post-operative time was 43 days.

21. At the time of extraction, a radiogram was obtained and a complete post-operative history was recorded.

22. All teeth are being sectioned and studied histologically.

Materials

Vital pulp amputations according to the technique described were performed on 228 teeth of patients in the Dental Department at the Great Lakes Naval Training Center. The average age of this group was 21 years with a range of 18 to 24 years. The great majority of these teeth had been ordered extracted because they had large carious exposures with severe destruction of the crown. The majority gave a history of severe pain of long duration. A few non-carious teeth which were ordered removed for prosthetic reasons and third molars in severe malocclusion, were also subjected to pulpotomy prior to extraction.

Findings

Table I summarizes the clinical evaluation of the results obtained using different calcium salts, various antibiotics and other agents. For the purposes of this study and because of the relatively short survival periods (average, 6 weeks), the criterion of post-operative pain rather than radiographic changes was used to evaluate the condition of the pulp. As indicated by previous investigators, especially Castagnola,[2] the first 8 to 14 days after vital pulpotomy are decisive in determining success or failure. Failures generally reveal themselves by painful complaints within this time.[2, 7, 15]

In this series there were only 24 instances (11%) out of 228 treated teeth in which severe post-operative pain was found. These were considered clinical failures. Two hundred and four teeth (89%) were classified as clinical successes and were completely asymptomatic or manifested only a slight transient thermal sensitivity. None of the teeth showed any postoperative radiographic changes.

TABLE I

Clinical Assessment of Different Agents Used in 228 Teeth Subjected to Vital Pulpotomy on Young Adult Males

Agent Used	No. Teeth	Clinical Success	Clinical Failure	Per Cent Failure
Calcium Salts				
Inorganic				
$Ca(OH)_2$ in methyl cellulose paste (Pulpdent—Rower)	13	13	0	0
$Ca(OH)_2$ in polystyrene-chloroform solution (Chembar—Caulk)	5	5	0	0
Calcium hydroxide powder	34	32	2	6
Calcium phosphate powder	35	32	3	9
Calcium carbonate powder	7	5	2	29
Organic				
Bone powder (defatted—Armour)	14	14	0	0
Dentin powder (human)	17	17	0	0
All Calcium Salts	125	118	7	6
Antibiotics				
Polyantibiotic Paste (PBSC—Grossman)	7	7	0	0
Tetracycline in various calcium salts 100 mg./gm.	8	8	0	0
Tetracycline in non-calcium diluents 50–100–250 mg./gm. (Aureomycin and Terramycin)	33	27	6	18
Penicillin Powder (undiluted)	11	7	4	36
Chloramphenicol in dicalc. phos. 100 mg./gm.	2	0	2	100
All Antibiotics	61	49	12	20
Zinc-Oxide-Eugenol Paste	14	14	0	0
Miscellaneous Agents				
Silver nitrate (Ammoniacal)	11	9	2	18
Phenol followed by Calc. Hydrox.	1	0	1	—
Gelfoam	3	2	1	—
Thymol Crystals	3	3	0	—
Beechwood Creosote	1	1	0	—
Sodium fluoride (4%)	1	1	0	—
Zinc phosphate cement	1	1	0	—
Aluminum disk	2	2	0	—
Gingival epithelium	1	0	1	—
Clot cauterized (heat)	2	2	0	—
Clot contaminated by saliva	2	2	0	—
All Miscellaneous Agents	28	23	5	18
Total	228	204	24	11

(All percentages rounded to nearest whole number.)

Antibiotics

In a series of 61 teeth in which various antibiotics had been used, there were 12 failures (20%). Potassium penicillin G powder (undiluted) and chloramphenicol appeared to be least effective of the antibiotics used, while Grossman's polyantibiotic (PBSC) paste was most effective (no failures in 7 attempts). This was supported by the observation that covering the blood clot with penicillin powder often resulted in dissolution of the clot, renewed bleeding and post-operative pain. The tetracycline drugs (Terramycin and Aureomycin) appeared to be more effective when diluted with various calcium salts than when used with other diluents (Table I).

Calcium Salts

On the whole, this group was superior to that of the antibiotics and manifested only 7 failures in 125 attempts (6%). Calcium hydroxide powder exhibited only 2 failures in 34 cases (6%). Calcium hydroxide appeared to be more effective when used as a paste in a methyl cellulose base (Pulpdent-Rower) or when suspended in a polystyrene-chloroform solution (Chembar-Caulk). The use of di- or tricalcium phosphate yielded 3 "failures" in 35 attempts (9% failures). Calcium carbonate yielded the least satisfactory results (2 failures in 7 attempts). This was confirmed by the clinical observation of clot dissolution, renewed bleeding and post-operative pain after the use of calcium carbonate.

There were no failures in 31 attempts following the use of a defatted bone powder (Armour) or dentin powder prepared from human teeth (Table I).

Other Substances Used

It is interesting to note that, according to the criteria used in this study, there were no failures following the use of zinc oxide and eugenol paste in 14 cases (Table I). Silver nitrate exhibited 2 failures in 11 attempts (18%).

A number of other agents were used on one to three teeth as indicated in Table I but no conclusions can be drawn from such small numbers.

Discussion

There is little doubt that the purely clinical evaluation of the success or failure of pulpotomy procedures is inadequate. Degeneration and even aseptic necrosis of the pulp do not necessarily reveal themselves through clinical symptoms. In fact, mild reparative inflammatory reactions yield painful symptoms yet may result in complete recovery of the pulp later.

Hess[7] has demonstrated that clinical evaluation is always more optimistic than justified after histologic investigation. Histologic evaluation is therefore sine quo non in studies of this type. All cases reported herein are being sectioned and evaluated histologically.

This preliminary clinical evaluation is nonetheless instructive in that (1) it confirms the high percentage of success of this procedure obtained by previous investigators; (2) it indicates that *clinical success* is predicated less upon the type of calcium salt or antibiotic used and more upon the technique and care taken by the operator. An important factor seems to be the presence of a well formed but thin blood clot which is allowed to form over the amputated area prior to placement of the medicament.

It is important to point out that in this series, no attempt was made to select cases with a "good" prognosis. All teeth had been condemned to extraction but had some vital pulpal tissue still remaining. In many instances, the bulbous por-

tion of the pulp was necrotic and the operator was obliged to go into the root canal to find vital pulp tissue which would bleed (partial pulpectomy). All teeth were accepted and treated. The only cases omitted from this series were those which were sensitive to biting pressure and percussion (evidence that inflammation had spread throughout pulp and entered the periodontal membrane) and those in which vital tissue could not be found even when the apical half of the canal was explored.

Summary

Pulpotomies were performed on 228 permanent teeth condemned to extraction because of large carious pulp exposures. The pulps were first sedated with zinc oxide and eugenol for 1 to 7 days prior to operation. The degenerated portion of the pulp was amputated until healthy pulp tissue was reached as evidenced by frank bleeding. A thin blood clot was allowed to form. This was covered with a calcium salt, an antibiotic or zinc oxide and eugenol and sealed with a fast setting zinc oxide and eugenol cement. Teeth were extracted 4 days to 9 months later and prepared for histologic study. From the clinical point of view, 89% were classified as successful, i.e., completely asymptomatic or with slight transient thermal sensitivity. Failures were considered in those cases where severe pain was present. Antibiotics resulted in 20% failures. Calcium salts produced 6% failures. There were no failures under zinc oxide and eugenol. Although the period of post-operative observation was relatively short, this study indicates that sedation of the pulp and sterilization of dentin prior to amputation, and a careful operative technique are probably more important to clinical success than the type of calcium salt or antibiotic employed to cover the amputated pulp.

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Tooth Development and Eruption

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SUGGESTIONS as to why the teeth erupt exist to the state of superfluity in the dental literature. Peculiarly enough, however, the amount of truly significant scientific research is appallingly meager in this abundance of material. This, perhaps, may be accounted for in the main by technical barriers, for the determination of growth and eruption patterns in the same individual appears beyond the realm of past and present techniques—especially insofar as the definitiveness of histological determinations are concerned. Cephalometry has demonstrated gross transitions and has provided valuable data towards the study of cranio-facial growth; yet histological methods still remain the only vivid and absolute means of study of tissue differentiation.

A review of the dental literature on tooth development and eruption need not necessarily be a cold, uninteresting and detailed account with no purpose other than reiteration of the past. Our predecessors rate far more credit than we duly place upon them, and far too often their works have been misrepresented by so-called "interpretations." The literature pertinent to this critique has been divided into five historical periods. The thoughts and researches on tooth structure and development and tooth eruption in each period were correlated, for it was felt that an investigation into what has prompted the present thinking and acceptance of ideas on our subject must include those findings. In order to circumvent the embellishment and misinterpretation of ideas which have a tendency to creep into repeatedly reviewed articles, each idea was traced to its source wherever possible and expressed as succinctly as possible in its original meaning.

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THE OBSERVATIONAL PERIOD (460 B.C.–1541 A.D.)

The inquisitive search for the origin and development of the teeth lagged far behind that of operative measures and care (i.e., treatment of toothache and extraction of teeth) during the centuries between 460 B.C. and 1541 A.D. Contributions to this field offered but mild enlightenment as to the number, disposition, composition and development of these organs of the jaws. The teeth were looked upon as "increments of the bones of the jaws and head."[1, 2] The number of teeth possessed by the adult male and female was repeatedly miscalculated and argued, and the belief that the teeth grew throughout life[2, 3] was unquestioned. There arose, however, one astute observation: The composition of teeth and bones was discovered to be different![2]

From such an unpretentious beginning, there followed a void sprinkled with a few insignificant observations (save those of Galen and Aetius[2] who found the teeth to be supplied by nerves and possessed of sensibility). This long period of famine in dental progress affords another glaring example of the stagnation of science during the dark ages.

Such a superficial inquiry allowed no disagreement to the evolved contention that the teeth grew from roots and were thusly shed.

The Anatomical Period (1543–1687)

Perhaps we might be more nearly correct were we to ascribe the actual beginning of dental science to the period of the anatomists Vesalius, Fallopius and Fabricus, for it is from this period that observations become supplemented by anatomical researches on the human body. For the first time, dentistry reached to a firm basis for development along scientific paths, leaving the days of the soothsayer and toothpuller to folklore.

Dental knowledge began to bear some semblance of synthesis with the acquisition of a recognition and description of the morphology of the teeth,[4] the primary dentition and its disposition and arrangement in the jaw prior to eruption,[3, 4, 5, 6, 7] the follicle of the tooth bud with its mode of growth and replacement by the secondary tooth and the dental lamina and the significance of its relationship to the new follicle.[5]

The belief that teeth grew like seeds—the roots remaining and sprouting new heads[8]—was thus forced to the background, and the mode of eruption was considered to be through the expanded dental lamina.[5]

The Histo-Anatomical Period (1687–1884)

The microscope not only gave the anatomists the tool they needed to understand more fully the structures with which they dealt, but soon fostered an inquisitiveness into what couldn't be seen. Hypotheses became as prevalent as investigators. The teeth, however, were taken from the category of extraneous organs "devoid of internal circulation and destitute of the living principle,"[9] and placed with the group of structures derived from the epithelial system[2] and very much invested with the "living principle."

The component parts of the teeth were being revealed, and their chemical composition established.[2] The understanding of the crystalline structure of enamel and tubular structure of dentin with recognition of cementum, secondary dentin and pulp tissue simultaneously precipitated studies in the development of the teeth.[2, 6, 7] It was soon admitted by the majority of investigators that the development of the teeth was obedient to certain laws of nature, that there were two dentitions—the first providing the needs of infancy and then shed to make room for the second, that they developed from minute papillae lying in the mucous membrane groove in the alveolar border of each jaw, that a dental lamina existed, that a tooth germ composed of an enamel organ, dental papilla and dental sac must exist for a forming tooth, and that dentin formation was initiated first but that enamel preceded it to completion.[5, 7, 10, 11] Observations were extremely accurate considering the imperfections of the instruments with which the studies were made.

The big questions during this period concerned the genesis of the different tissues and the interpretations of what was seen. The mechanism of enamel formation was still obscure. The accepted theory was that each ameloblast calcified and was replaced by a cell from the intermediate layer of the enamel organ;[7] however, another group considered the ameloblast a secretory duct or gland which secreted the "earthy salts."[6] Dentin formation, although the description of dentin was good, was also obscure,[12] but very good resumés of the soft tissues (pulp and periodontal membrane) were excellently presented.[7]

With each new-found wealth of histological data, there seemingly arose a theory of tooth eruption: lengthening of the root,[13, 14] pressure of the alveolus upon

the root driving the tooth towards the gum,[2,14] mechanical action of the crown of the tooth destroying the tissues adjacent to it,[9] and contraction of the dental sac which moves the tooth through the dilated orifice of the sac.[6] Physiologists of the time largely adhered to a "physiological resorption" hypothesis which attributed the principal cause of eruption solely to the gradual pressure exercised by the developed tooth on the enamel organ and on the summit of the follicle which soon gave way as did the overlying gum.[7, 13] The "gubernaculum denti" (dental lamina) was considered the agent which guided the tooth during its process of eruption.[7] The most significant contributions to the eruption picture were the excellent observations as to the order of eruption of the primary and permanent teeth[7] and the beginning work on bone growth in relation to "teething."[14]

The Physiological Period (1884–1927)

The careful histological preparations of J. L. Williams[15] and the artful and scientific interpretative pursuits of this man to a certain extent culminated the histological ascent in the dental field. Williams capably summed up certain disputed points in the development and histology of the teeth and cast undeniable doubt on the dogmatic interpretations that existed.[16] Sudduth[17] corroborated Williams' findings; and it appeared that histological pursuits had reached an impasse. Thus it was that the spread toward the unexplained phenomena developed. The forces behind growth processes and tooth eruption were enthusiastically sought, but unfortunately the findings were more speculative than based on experimental evidence.

Eruption, it was soon realized, was not a continuous process but included periods of growth and rest which are modified by conditions controlling the "function of nutrition."[18] A mechanical force brought about by the repeated closing of the jaws was soon added,[18] and soon other mechanical forces[19, 20] were thrown into the gargantuan mouth of explanation to meet the discrepancies and arguments that crept up to baffle the proponents of many of the theories.

The blood pressure of the vascular tissues which lie between a developing tooth and its bony surroundings,[21] the force of cellular activity at the base of the dental papillae[22] and a series of bone currents with absorption of alveolar margins[23] were suggested as means by which the teeth are brought to the surface. But because certain facts about the eruption of teeth could not be satisfactorily conciliated with mechanics, a turn to the unknown factors which could not be easily attacked gave new life to the timid ubiquitous opinion that eruption was a natural physiological process which must take its turn in the development of the body.[24, 25, 26]

The discovery of the hormones added its influence to the ever increasing search for an explanation to the eruption process, and it was suggested that hormones sensitized growing tissues rendering them susceptible to mechanical impulses which arise from natural use of parts.[27] That an endocrine imbalance was a definite factor in the eruption process[28] appeared of significance but still became only a parcel to the main part. Experimental evidence during this entire period reached a new low, and because of this paucity a new era began its evolution.

The Experimental Period (1927 and Onward)

As the sound investigations of the past were gradually constructing a catwalk of

scientific data, they were unfortunately being camouflaged by the more numerous speculative interpretations which were offering explanations for being or happening. So much of this conjecture existed that apparently it stimulated an era of scientific experimentation which less eagerly sought explanation and more earnestly desired substantial accumulations of factual material to warrant the developing of hypotheses. For example, an experiment on the influence of tooth cell substances on growth and structure of teeth was soon completed, and the results used to add support to the hormonal theory.[29]

As near as can be ascertained, the determination of tooth growth and eruption by measurement was initiated in 1928.[30] Measurements from the floor of the nose to the upper central incisor tooth germ to the epithelium of the mouth gave figures which fixed Hertwig's sheath as a relatively fixed point in the growth of the tooth. Several years later the above findings were substantiated by histological and roentgenological studies of the first mandibular molar in the human and its relationship to the mandibular canal.[31, 32] It thus appeared that the entire growth of both crown and root took place in an occlusal direction out of the jaw. Serial cephalometric studies in the same individual,[33] however, traced a slight downward growth of the root following crown completion which was not accompanied by any acceleration in occlusal movement of the germ. The root forced its way into the bone of the jaw upon completion, and the entire tooth rose with the occlusal plane.

Cephalometric studies correlated with histological ones[34] brought a more intimate tooth-jaw relationship with emphasis on mandibular growth. Here it was found that the first permanent mandibular molar did not sink into the jaw or move forward as was previously thought. The illusion of this was brought about by the rapid migration of the primary teeth and vertical growth of the mandible. The illusion of axial movement was the result of the mandible growing in length by additions to its posterior border with resorption of the anterior margin of the ramus, which allowed the molars to be uncovered by the retreat of the anterior margin of the ramus. Each succeeding molar erupted at the same distance from the posterior margin of the ramus and in an almost vertical direction.

It became apparent that mandibular growth was a matter of surface deposition and resorption of bone with the body growing in height (depth) at the free border of the alveolar process and an insignificant amount at the inferior border;[35, 36, 37, 38] that the intimate association of crown development and the adjacent bone metabolism, in the main, accounted for tooth movement during its growth;[37, 38, 39] and that the dental organs definietly influence the final development of the jaws.[40, 41]

Vital staining was used in the rat to permit a measurement of the rate of alveolar bone and cementum apposition and the rate of eruption.[42] The findings indicated that tooth development in the rat was a "continuous process" and that the actual occlusal movement was equal to the sum of the amount of root elongation and the total of the apposition of fundic bone.

The complexity of tooth growth and development became profoundly apparent when it was found that aside from a genetically controlled factor, biologic function, nutrition, body growth, sex, race, geographic distribution, climatic conditions, social levels and economic

well-being were all related in the growth of the face, jaws and dentition.[43, 44, 45, 46]

Although the teeth have been critically analyzed,[47] every phase of their formation and development remains to some extent controversial or obscure. The structural configuration of the tooth is little questioned since scrutiny by electron microscopy and other new microscopic advances. The descriptive stages of tooth formation have been aptly transcribed with histomorphodifferentiation of tissues definite.[48, 49] It is the developmental and biological aspects that block understanding and still bring forth controversial data. Amelogenesis, dentinogenesis, cementogenesis and osteogenesis investigations are now turning to the biochemical and enzymological fields for further explanation.

This period has not been without its unsubstantiated speculations, for authors still seek explanations for unknown entities that cannot be solved with any of the modern tools except the mind. No criticism is leveled at the investigator who utilizes the known factors in building up his concept, but those who base contentions on disputed or controversial points only add further burden to the conscientious research worker.

Since it was experimentally shown that in mandibular development, alveolar bone growth is a continuous process, and that in the mandible, growth is in the main the result of alveolar bone apposition,[35] the thinking turned to the consideration that eruption of the tooth and its movements were necessarily a part of the general process which included the addition of cementum to the root surface in the slow extrusion to full eruption.

Thus, it is now that eruption has been incorporated with all other growth and developmental processes and not placed apart on a mechanical basis. It has been divorced from the local phenomenon stage and become an "episode in the growth of the jaws" with proliferation of the socket base and growth of the root acting as the "forces of eruption."[50]

Discussion

Despite the numerous good experimental and observational findings, interpretations of these findings precipitate contradictory conclusions which eventually lead us nowhere. The goal, it appears, has been to find the eruptive force which propels the tooth into the oral cavity. This, actually, indicates the thinking still presupposes a mechanical basis for eruption—that there must be either forces within the tooth acting upon a resistive substrate, or forces without the tooth (in the bone) pushing the tooth into the oral cavity.

Sicher[51] aptly indicates that a mechanical explanation of tooth eruption isolates the process from all other developmental and growth phenomena. He views the erupting teeth as but parts of the organism, growing and moving in the environment of living tissue. This contention must be given complete support.

Eruption, paradoxically enough, at the present time is considered to begin at the time of root formation and to continue throughout the life span of the tooth.[52] There must be some dissent with this statement. Why again is this phenomenon being set apart from the rest of the body? What other developmental process perpetrates itself in the body unto death? Is the continued growth of the nails developmental? Physiological function's progressive steps are cancelled by subsequent regressive steps of equal momentum. The fleeting change brought about by a deviation in direction is can-

celled by opposing forces of equal magnitude. The basic condition of the organ is left unaltered.

In contrast, developmental changes are cumulative and progressive, producing new structures, new shapes, new configurations. If eruption is to be considered a growth and developmental process, one cannot conceive of the phenomenon being contradictory to the principles of growth and development. The phase of so-called "passive eruption" should be considered an "extrusion"—a physiopathological process and not a part of the growth and developmental period. The extrusion related to teeth with no antagonist falls in the same category, although the period of eruption would still have preceded the period of extrusion.

Were we not to expect a certain end-result known by all, but be aware of certain progressive changes which lead from one avenue to another, our concept of eruption would be based on mechanisms, not factors which alter these mechanisms and either hasten or retard their natural progression. It is true that both concepts are important in our way of thinking, but let us rather be retrospective than prospective in our inquisitiveness into the phenomenon of eruption. If we were to consider the life span of one continuous developmental process there would be no recourse to the present views on eruption. But there must be many who do not hold that consideration.

Perhaps it might be well to illuminate the process further in the light of our preceding statements. That development of the teeth and growth of the jaw are simultaneous and interdependent processes[52] is not questioned, it is rather the definition of terms which indicate when the growth and development process ends, the period of dynamic equilibrium exists and the period of degeneration begins. In this author's view, eruption of the teeth takes place in the first period mentioned, and physiological eruption is that entire period until the tooth reaches its antagonist or normal occlusal height in the mouth. Such a view finds support from the study on the rest position of the mandible[53] which indicated that eruption of the teeth with the resultant forcing of jaws apart is a misconception since the rest position is stable and unrelated to the presence or absence of teeth. Passive eruption or the so-called continuous eruption through further cementum formation at the root ends and attrition of the crown no longer can be considered a part or parcel of the period of growth and development, but must fall into the period of "catabolism" or degeneration or pathology. Movements of the teeth which occur after these organs have reached their "predestined" position in the arch also come under that category.

Growth studies have from the time of Hunter aided each other in resolving the phenomenon of growth to fairly accurate dimensions. It is unanimously agreed that organs of the body do not function as independent individuals, but maintain constant interrelationships.[54] Those who have repeatedly contended the teeth to be completely separate organs with special separate phenomenal action discrete unto themselves fail to observe the principles set down in growth and development and have thus brought forth numerous hypotheses on the eruption process contradicting those principles.

Eruption and growth should not be divorced from each other during the developmental period of the tooth and its surrounding structures. We might possibly draw an analogy from the works of Weiss[54] on the development of organ

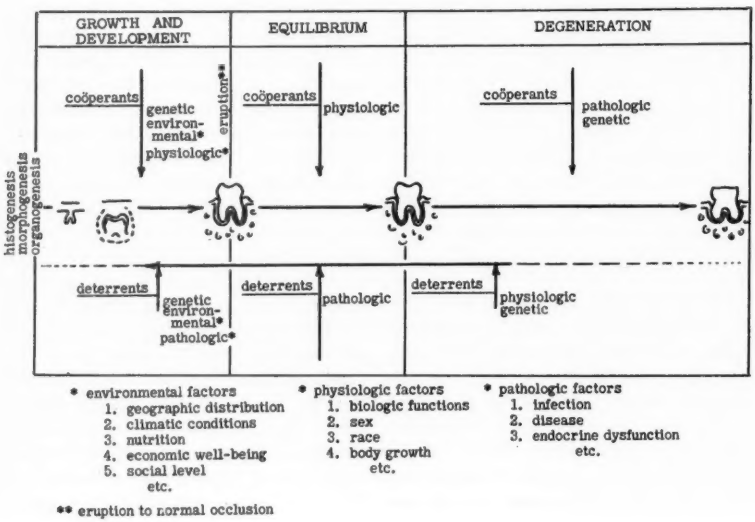
characters to elucidate this statement. In a comparison of the two end points of the developmental line our views may perhaps change to some extent as to why, how and when the eruption process proceeds. Certain characters of an organ cease to exist in tracing that organ back to its incipient stage, and the first to disappear is specific function. In the molar, mastication is presumably its specific function. Once this property is accomplished, the end of the developmental chain has been reached and the course of equilibrium ensues. Hence eruption which is a part of the developmental stage of the tooth ceases with the beginning of the stage of equilibrium. In the case of lack of specific function, the absence of correlating systems must be considered.

The shape of the tooth becomes less distinct in our step towards retrogression. The tooth loses its convolutions and cusps and takes on a more simple shape until the bud stage—a simple sphere—is reached.

Complexity within the organ decreases noticeably to indicate the retrogression to simpler structure. For example, root structure is simple, and the contents of the enamel organ are purer and more homogenous. The cell types lose their distinctiveness.

Finally, however, it we trace back the relations between the tooth and the jaw, we find that their spatial relationships have shifted considerably during development. It is by virtue of this last analogy that it is assumed the tooth will not lose the tendency to erupt except if prohibited by other interfering developmental forces. In view of this consideration of spatial relationships being the most primitive and hence the least likely of all salient features in the develop-

THE TOOTH AND PERIODONTAL LIFE PERIODS



mental chain to be lost, the eruptive process would be fulfilled despite the fact that loss of specific function would not be fulfilled. To define eruption in this light would be to consider it a change in the spatial relationships of the teeth to the jaws during the growth and development of each.

The general principle of morphogenesis—"local progress when once established tends to persist and to suppress by this very fact the manifestation of similar tendencies, within its vicinity"[54]—again tends to support eruption as a growth and developmental phase of the tooth; for we have seen that growing and erupting teeth determine the deposition of alveolar bone. Only when bone development ceases and cannot parallel tooth development do the intrinsic factors in growth of the tooth become subservient to the resistance of the environmental factor resulting in a stifling of tooth development (both growth and eruption).

The fact that the tooth begins to erupt prior to completion of its adult form (root completion) indicates the complexity of correlated growth and developmental features. The stimulus, it appears, is the initiation of root formation. The directional velocity of tooth growth and the sensitiveness of the environmental tissues can afford the route of eruption by the process of resorption through the application of a biophysical force. Any deviation from this norm, such as embedded teeth, impacted teeth, etc., might result from a disruption in the developmental process, either in the environmental stability, or loss or disruption in the directional movement of the tooth itself, or a combination of both. A concept of the various factors involved in the eruption of the teeth might diagrammatically be presented in plate I.

Where must all this lead us? It is hoped that the foregoing discussion affords eruption of teeth the substantial foundation it has been seeking, that it no longer is made to fit the individual theory or experiment with the purpose towards individual appraisal or confirmation, and that the useful information has been integrated and an attempt made towards the formulation of the process of eruption. It is for future biometric and histologic studies to clarify the progressive steps in the mechanism of eruption.

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A. E. S.

Book Review

SOGNNAES, R. F. ed. *Advances in experimental caries research*. American Association for the Advancement of Science, Washington, 1955. IX + 236 p.

This book is based upon a symposium presented at the 120th Annual Meeting of the American Association for the Advancement of Science, Subsection on Dentistry. The eleven chapters have been contributed by a total of twenty investigators representing not only dentistry, but the various basic sciences.

The first chapter serves as an adequate introduction to the problems confronted by a researcher in dental caries. The selection of test animals, nature of experimentally produced lesions, and the evaluation of the experimentally produced lesions are described in considerable detail. The material for this chapter was drawn from the leading caries research articles of the literature covering the last thirty-five years.

The second chapter deals with the location of experimental caries on different tooth surfaces of the rat. How the caries is found and evaluated is discussed in addition to a description of the dietary factors necessary for the production of fissure and smooth surface caries.

Each of the following factors that influence dental caries, genetic, developmental, dietary, salivary and endocrine is treated quite completely and individually in the next five chapters.

The chapter dealing with intraoral effects upon experimental hamster caries discusses the following factors: (1) tooth morphology; (2) types of carbohydrates ingested; (3) eruptive age factor; (4) salivary function; (5) influence of tooth brushing and therapeutic dentifrices.

The discussion in chapter 9 regarding the oral environmental factors describes the use of germ free animals in dental caries research. The report is concerned with two definitive caries producing factors, microorganisms and food substrate in the oral cavity. The series of experiments described showed that no dental caries occurred in rats reared entirely free of microorganisms or which were fed by a stomach tube that bypassed the oral cavity completely, indicating that oral food debris and bacteria are essential for caries to occur in the rat.

The influence of antibiotics and various other agents upon experimental caries composes the next two chapters.

The book is completed by a general summary by the editor in which all the material presented in the book is correlated and listed in 9 brief categories.

This book represents an excellent comprehensive review of recent caries research in animals, bringing together under one cover all of the most fruitful experimental caries research in the last thirty-five years. The American Association for the Advancement of Science is to be congratulated for sponsoring such a worthwhile and much needed project for the benefit of the dental profession.

WILLIAM F. VIA, JR.